KONSTAN
JURNAL FISIKA DAN PENDIDIKAN FISIKA
Volume 11, Number 1, June 2026
E-ISSN : 2460-9129 dan P-ISSN : 2460-9110
http://jurnalkonstan.ac.id/index.php/jurnal

The Sun's Influence on Extreme Weather: A Study of Solar Declination and Sunlight Intensity on Rainfall Extremes in West Sumatra, July–December 2025

Khairul Anisa [1,*)], Letmi Dwiridal[2], Harman Amir[3], Hidayati[4]

[1),2),3),4)] *Department of Physics, Faculty of Mathematics and Natural Sciences, Padang State University*
Jl.Prof. Dr. Hamka FMIPA UNP Freshwater Campus, Padang City, West Sumatra, Indonesia 25131

*E-mail correspondence: anisakhairul17@gmail.com

Article info:

Sent:
July 23, 2026

Revision:
August 02, 2026

Accepted:
August 04, 2026

Keywords:

Extreme rain, Flash floods, Landslides, Light intensity, Solar declination, West Sumatra.

Abstract

West Sumatra is one of the regions in Indonesia that is vulnerable to extreme rains that often trigger hydrometeorological disasters, such as floods and flash floods. These incidents have an impact on infrastructure damage, disruption of socio-economic activities, and increased risks to public safety. This study aims to analyze the relationship between solar declination, light intensity, and extreme rainfall events in West Sumatra during July–December 2025. The study used 184 daily data points. Rainfall data were obtained from the West Sumatra Climatology Station, Teluk Bayur Maritime Meteorological Station, and Minangkabau Padang Pariaman Class II Meteorological Station. Light intensity data were obtained from the Class II Minangkabau Padang Pariaman Meteorological Station, while solar declination data were sourced from the National Oceanic and Atmospheric Administration (NOAA). The analysis was carried out using descriptive statistics, graphical visualization, spatial mapping with Surfer software, and Spearman correlation tests. The results show that the flash flood in East Malalak (Agam) on November 26, 2025 occurred when the Sun declinated around −21.3°, the intensity of light ranged from (160,000–180,000)W/m², and rainfall reached (200–220)mm. On 27–28 November 2025, light intensity decreased to (40,000–50,000)W/m², while rainfall increased to (430–500)mm and flooding extended to some areas in Agam, Padang, and Padang Panjang. The results of the Spearman test show that light intensity has a stronger negative relationship with precipitation compared to the declination of the Sun ($\rho = -0.428$), so it has the potential to be a supporting parameter in monitoring atmospheric conditions when combined with other meteorological parameters. This study is limited to the use of light intensity data from a single observation station and correlation analysis that only shows statistical relationships, so further research with multi-station data and more diverse atmospheric variables is needed to gain a more comprehensive understanding.

INTRODUCTION

Indonesia is located in the tropics and is crossed by the equator, so it receives relatively high levels of solar radiation throughout the year. The amount of solar radiation that reaches the Earth's surface is influenced by changes in the Sun's apparent position, which is represented by its declination, as well as various atmospheric factors including cloud cover, moisture content, and air circulation patterns.[1]. Light intensity plays an important role in maintaining atmospheric energy balance as it controls surface heating, cloud formation, convection, and ultimately precipitation. Therefore, variations in the Sun's declination are followed by changes in light intensity that contribute to changes in rainfall patterns, especially in tropical climates such as in Indonesia.

One of the regions with complex atmospheric characteristics is West Sumatra. Its location directly facing the Indian Ocean and the existence of the Bukit Barisan Mountains make this area vulnerable to the formation of convective clouds due to orographic lifting of air masses. The interaction of these two factors increases the likelihood of high-intensity rainfall that has the potential to trigger hydrometeorological disasters[2]. Forecast information from the Meteorology, Climatology, and Geophysics Agency (BMKG) shows that the July-December 2025 period will be a transition phase to the rainy season in most parts of Indonesia, including West Sumatra[3]. This condition occurred at the end of November 2025, when very high-intensity rainfall caused flash floods in several areas, including East Malalak and Palembayan (Agam), Koto Aia and Koto Tangah (Padang), and the Twin Bridges (Padang Panjang). Of these locations, East Malalak experienced the greatest impact, as seen from house damage, disruption of transportation routes, and disruption of community activities due to flash floods and landslides. This event shows that extreme rainfall remains a hydrometeorological threat that requires more in-depth research.

Previous research has identified various factors that affect rainfall variations in Indonesia. Most studies have focused on the influence of global atmospheric phenomena, such as El Niño–Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), Madden–Julian Oscillation (MJO), and monsoon systems, on changes in rainfall patterns[3]. On the other hand, some studies show that changes in the declination of the Sun affect the distribution of solar radiation, thus influencing changes in meteorological elements, such as temperature and air humidity[4]. Light intensity is also known to be related to the dynamics of cloud formation and can therefore be used as an indicator of atmospheric conditions[5]. However, research that integrates the declination of the Sun as an astronomical parameter with light intensity as an indicator of atmospheric conditions to explain the occurrence of extreme rainfall simultaneously, particularly in West Sumatra, is still relatively limited.

Based on these studies, the main contribution of this study is to examine the relationship between solar declination, light intensity, and extreme rainfall events during the July–December 2025 period in West Sumatra. This study not only analyzes the statistical relationship between variables, but also relates the results to flash floods that occurred on November 26–28, 2025 in several affected areas. This study proposes a more comprehensive approach by integrating astronomical factors, atmospheric characteristics, and hydrometeorological events to explain the mechanisms of extreme precipitation.

Various previous studies have discussed the influence of global atmospheric phenomena, such as ENSO, IOD, MJO, and the monsoon system, on rainfall variations in Indonesia. Meanwhile, studies on the influence of solar declination are generally only associated with changes in meteorological parameters, such as air temperature and humidity, while studies linking solar declination, light intensity, and extreme rainfall events simultaneously are still relatively limited, especially in West Sumatra.

Based on the research gap, this study aims to analyze the relationship between Solar declination, light intensity, and extreme rainfall during the period July–December 2025 in West Sumatra using statistical analysis and spatial visualization. This study is not intended to prove cause-and-effect relationships, but rather to identify statistical relationships between variables as preliminary information in understanding the characteristics of extreme rainfall in the study area.

Based on the theoretical foundation, the hypothesis is that variations in the Sun's declination and light intensity are related to the occurrence of extreme rainfall in West Sumatra during the July–December 2025 period. The increasingly negative declination value of the Sun is expected to be followed by an increase in rainfall tendency due to changes in the distribution of radiation energy that affect atmospheric conditions indirectly. In addition, the decrease in the intensity of light reaching the Earth's surface is thought to be related to increased cloud cover and convective activity, so it is likely to be followed by an increase in rainfall. Thus, this study assumes that light intensity has a stronger relationship with rainfall variation compared to the declination of the Sun because light intensity is more reflective of atmospheric conditions at the time of cloud formation and precipitation. The hypothesis was then tested using Spearman correlation analysis to determine the direction, strength, and significance of the relationship between the Sun's declination, light intensity, and precipitation.

RESEARCH METHODS

This study uses a quantitative approach by utilizing secondary data during the July-December 2025 period, with as many as 184 daily data points. The research data came from several sources according to the type of variables analyzed. Rainfall data were obtained from three BMKG observation stations: the West Sumatra Climatology Station, the Teluk Bayur Maritime Meteorological Station, and the Class II Minangkabau Padang Pariaman Meteorological Station. The use of several stations aims to describe the spatial variation of rainfall in several areas of West Sumatra that are the locations of extreme rainfall and hydrometeorological disasters, while light intensity data is obtained from the Class II Minangkabau Padang Pariaman Meteorological Station, and the Solar declination data is calculated based on astronomical data obtained from the National Oceanic and Atmospheric Administration (NOAA) using daily ephemeris data. All data is then adjusted based on the date of observation so that each variable has the same daily data pair for statistical analysis purposes.

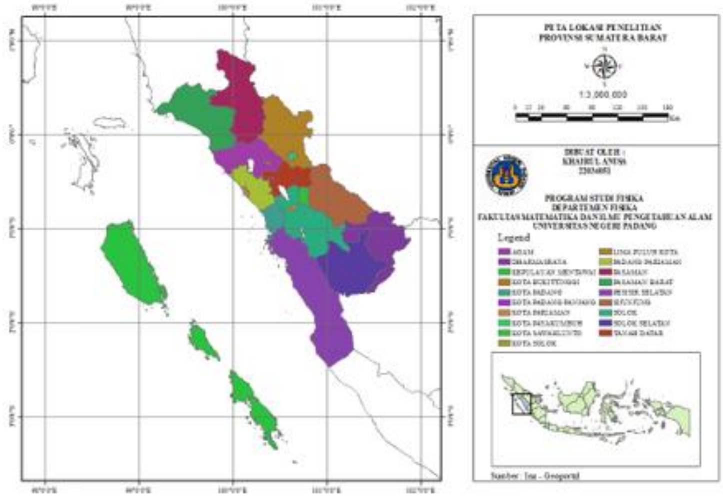


Figure 1. Map of the Research Location

Geographically, West Sumatra is located between 0°54' North Latitude and 3°30' South Latitude as well as 98°36' East and 101°53' East Longitude. It borders the Indian Ocean to the west and has a diverse topography, encompassing coastal areas, lowlands, and the Barisan Mountains for most of its territory. This combination of geographic location and topographic characteristics favors the formation of convective and orographic precipitation, increasing the potential for high-intensity rainfall, especially during the rainy season. Based on these characteristics, West Sumatra was chosen as the research location to examine the relationship between solar declination, light intensity, and extreme rainfall events[6].

This study has three types of variables, namely independent variables, dependent variables, and control variables. An independent variable (X) is a factor that is thought to affect another variable, while a dependent variable (Y) is a variable that responds to or produces such an influence. Control variables are factors that are kept constant throughout the study to prevent influences that may interfere with the results of the analysis. Variable control is performed to minimize bias derived from factors outside the study, so that the relationship between independent and dependent variables can be evaluated more accurately and produce more valid findings[7].

1. Solar Declination Data

   The Sun's declination is the angle that indicates the Sun's position relative to the celestial equator. Declination values change throughout the year due to the apparent annual movement of the Sun, ranging from +90° to the north celestial pole and -90° to the south celestial pole.[4]. The declination position in the northern hemisphere shows a positive value, while the position in the southern hemisphere shows a negative value. Changes in declination values affect the distribution of solar radiation on the Earth's surface, making it a major factor that influences variations in air temperature over time.[8]. The Sun's declination value reaches a maximum variation of +23.45° and a minimum variation of -23.45°. The declination quantity can be calculated using Per. (1), where the variable (n) represents the order of days in the year, with (n = 1) indicating the first day, i.e., January 1[9].

The data on the declination of the Sun is calculated using astronomical equations based on the nth day (Julian day) of the year.

$$\delta = 23{,}45^\circ \sin\left[\frac{360}{365}(284 + n)\right] \tag{1}$$

This data is used as a variable (X_1) to determine the effect of changes in the position of the Sun on extreme rainfall events in West Sumatra. Data are obtained from astronomical calculations based on ephemeris data using astronomical software or official data sources that provide daily declination information on the Sun[10].

2. Light Intensity Data

Light intensity is the amount of electromagnetic radiation energy emitted by the Sun and received by a surface in units of area over a certain period of time. In the field of meteorology and hydrology, light intensity is known as global solar radiation (GSR) or global solar radiation consisting of direct radiation and diffuse radiation. This parameter is expressed in units of W/m^2 for momentary measurements or $MJ/m^2/day$ for daily accumulation. The intensity of solar radiation is the main source of energy that controls the Earth's energy balance, so it affects surface temperature, evaporation, evapotranspiration, cloud formation, and the rainfall process, which is an important part of the hydrological cycle[11].

In addition to atmospheric conditions, light intensity is influenced by astronomical factors, such as geographic latitude, solar zenith angle, sunshine duration, and Earth's relative distance from the Sun. When the sun is at a small zenith angle, the radiation trajectory through the atmosphere becomes shorter, so that the energy received by the Earth's surface is greater. Conversely, at a large zenith angle, the radiation trajectory is longer, so that the absorption and scattering process in the atmosphere increases, causing the intensity of radiation reaching the Earth's surface to decrease[12].

In hydrometeorological studies, the intensity of sunlight is the main component that controls the evaporation and evapotranspiration processes. Increased radiation intensity causes the surface temperature of the soil and water bodies to increase, accelerating the evaporation of water into the atmosphere. The water vapor then condenses if atmospheric conditions support it and forms clouds, which subsequently produce rain. Therefore, variations in light intensity affect the distribution of rainfall, soil moisture, and the availability of water resources. Guo *et al.* (2021) show that changes in solar radiation are one of the meteorological factors that influence the development of meteorological droughts through their influence on potential evapotranspiration.

On the other hand, a continuous increase in light intensity without being compensated for by rainfall can increase water loss from the soil surface and vegetation. These conditions cause a decrease in soil moisture, reduced river discharge, and an increased risk of hydrological drought. In contrast, in humid atmospheric conditions, surface heating due to solar radiation can increase convection, triggering the formation of cumulonimbus clouds that produce high-intensity rain. This phenomenon shows that light intensity is closely related to hydrometeorological disasters, both in the form of drought and extreme rain[13], [14].

Light intensity data describes the amount of solar radiation energy the Earth's surface receives each day during the study period. In this study, light intensity was established as an independent variable (X_2). The value of light intensity is expressed in $MJ/m^2/day$ or W/m^2 in accordance with the data format obtained from BMKG Class II Minangkabau Padang Pariaman. This data was used to examine the relationship between variations in light intensity and extreme rainfall events in West Sumatra[15].

3. Rainfall Intensity Data

Rainfall is the amount of rainwater collected in an area over a period of time and is generally expressed in millimeters (mm). The amount of rainfall reflects the volume of rainfall received on the Earth's surface at the observation site. In Indonesia, the distribution of rainfall shows significant variation between regions due to various factors, such as topography, elevation, geographical location, and atmospheric dynamics. Therefore, identifying and analyzing rainfall patterns is an important step in understanding the characteristics of rainfall and supports a wide range of meteorological and climatological research[4].

Extreme rainfall can result in flooding that causes significant losses to the economy and people's lives, with a high impact on the most vulnerable areas and devastating social, ecological, and environmental impacts.[16]. Extreme rainfall of high duration can cause severe flash floods; it can be more dangerous than rainfall with a longer duration[17], [18].

Daily rainfall data is used as a dependent variable (Y). Data were obtained from the Meteorology, Climatology, and Geophysics Agency (BMKG) for the West Sumatra region from July to December 2025. Rainfall is expressed in mm/day. This study refers to the BMKG classification, where extreme rainfall is defined as the occurrence of daily rainfall exceeding 100 mm/day, categorized as very heavy or extreme rainfall[19].

As an international comparison, the World Meteorological Organization (WMO) states that extreme rainfall is generally determined based on statistical thresholds, such as the 95th or 99th percentile of the rainfall distribution in an area, so the threshold value can differ according to its climatological characteristics. Therefore, the BMKG classification is used as an operational reference in this study, while the WMO definition is used as an international conceptual reference[12].

4. Data Processing Software

The study uses several software tools to support data processing, analysis, and visualization, including:

Table 1. Software Functions and Functions

Software Functions	Function
Microsoft Excel	Data tabulation, data cleansing, preliminary calculations, and graphs
Statistics IBM SPSS	Statistical tests include descriptive statistics, normality tests, and Spearman correlation tests.
Golden Software Surfer	Create contour maps and spatial visualizations of the relationship between solar declination, sunlight intensity, and precipitation.

This research instrument was used to obtain valid data on the relationship between solar declination, light intensity, and extreme rainfall events in West Sumatra. The data that have been collected are then calculated, verified, and processed using statistical software before the analysis process is carried out. Several stages aim to ensure the quality of the data and produce information that is able to explain the relationship between independent variables and bound variables precisely according to the research objectives.

5. Data Collection Techniques

Data collection in this study was carried out through a documentation method by utilizing official observation data published by the Meteorology, Climatology, and Geophysics Agency (BMKG). Data on light intensity were obtained from secondary data from BMKG Class II Minangkabau Station, while daily rainfall data were obtained from secondary data from several BMKG stations.

The value of the Sun's declination is calculated using astronomical equations based on the order of days (n) in a year. The process of calculating and processing data is carried out with the help of software such as Microsoft Excel and SPSS to obtain data that can be analyzed at a later stage[7].

6. Data Analysis Techniques

The relationship between variables in this study was analyzed using the Spearman correlation test. This method was chosen to measure the direction and degree of correlation between research variables without the need for normally distributed data. The degree and direction of the relationship are indicated by the value of the Spearman correlation coefficient (r), while the significance of the relationship is determined by the *p-value*. The calculation of the Spearman correlation coefficient refers to Per (2)

$$r = \frac{n\sum XY - (\sum X)(\sum Y)}{\sqrt{[n\sum X^2 - (\sum X)^2]\,[n\sum Y^2 - (\sum Y)^2]}} \tag{2}$$

In correlation, the test can be positive or negative.[20].

The calculation of correlation coefficients is done with the help of Microsoft Excel or SPSS software to simplify the data processing process and improve the accuracy of the analysis results. The direction of the relationship between variables, both positive and negative, is determined based on the value of the correlation coefficient, which refers to the interpretation criteria presented in Table 2.

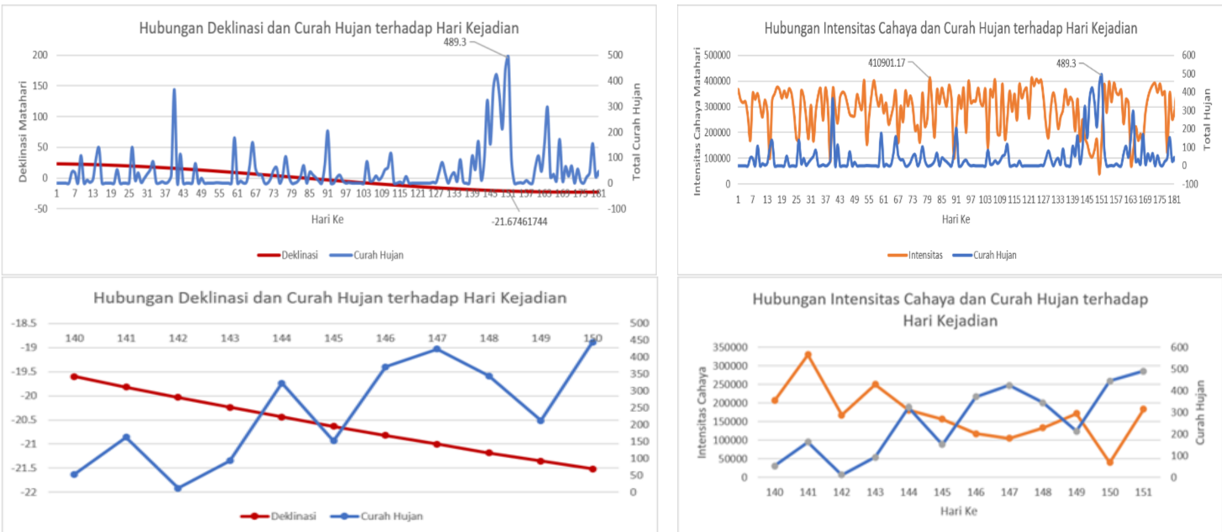
Table 2. Correlation Rate

Interval Coefficient	Relationship Level
0.00 – 0.199	Very weak
0.20 – 0.399	Weak
0.40 – 0.599	Medium
0.60 – 0.799	Strong
0.80 – 1.000	Very Powerful

The significance of the relationship between variables was analyzed using the Spearman correlation test because the data did not require a normal distribution. The interpretation of the results is based on the value of the correlation coefficient (ϱ) and the significance value (*p-value*), with a relationship stated to be significant if p < 0.05; then the relationship between variables is statistically insignificant, so there is not enough evidence to conclude that there is a meaningful correlation[7].

RESULTS AND DISCUSSION

Based on the data processing results, the relationship between solar declination, sunlight intensity, and rainfall occurrence is illustrated in Figure 1.

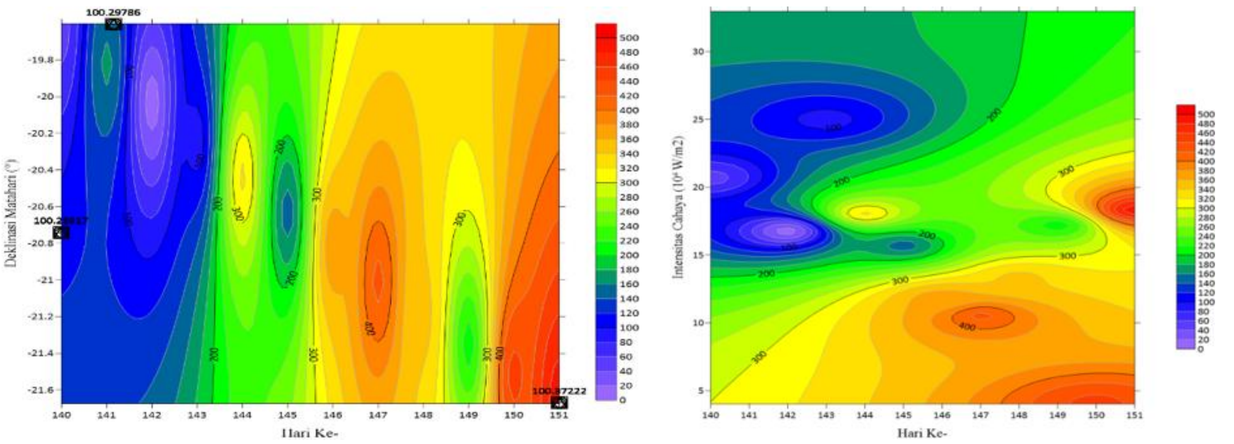


(a) (b)

Figure 1. a) Graph of Solar Declination and Precipitation by Day of Occurrence, b) Light Intensity and Precipitation by Day of Occurrence

Based on the graph above, it is shown that the more negative the declination of the Sun, the more precipitation. On the other hand, the intensity of light will decrease further as rainfall increases. This pattern shows an opposite (negative) relationship between the Sun's declination and precipitation, as well as between light intensity and precipitation. Seen on November 17, 2025, the

Declination of the Sun is -19.6°, the intensity of light is (200,000–220,000) W/m², and the rainfall is 53.1 mm. Ahead of the period of extreme precipitation events on November 26–28, 2025, the Sun's declination changes to about -21.3° to -21.7°, the intensity of light decreases to (40,000–180,000) W/m², while precipitation increases to about (200–500) mm. The contour of declination and light intensity to precipitation can be seen in Figure 2.



(a) (b)

Figure 2. a) The relationship between the sun and the declination of the Sun to the rainfall of the observation period, b) The contour of the relationship between the day of the day and the intensity of light to the rainfall of the observation period

Figure 2 shows that the contours with red color gradations represent a higher value; Instead, the color gradation of purple represents a lower value. Based on this pattern, it can be seen that rainfall tends to increase when the Sun's declination is at its most negative value. This study shows that changes in the Sun's declination do not directly determine the amount of rainfall, but rather interact with various other atmospheric factors. On the other hand, extreme rainfall events generally occur when the intensity of light is at its lowest. This phenomenon is related to an increase in cloud cover that inhibits the irradiation of the Sun to the Earth's surface so that the intensity of the received light becomes lower. An analysis of the relationship between the Sun's declination, light intensity, and precipitation can be seen in Figure 3 and Figure 4.

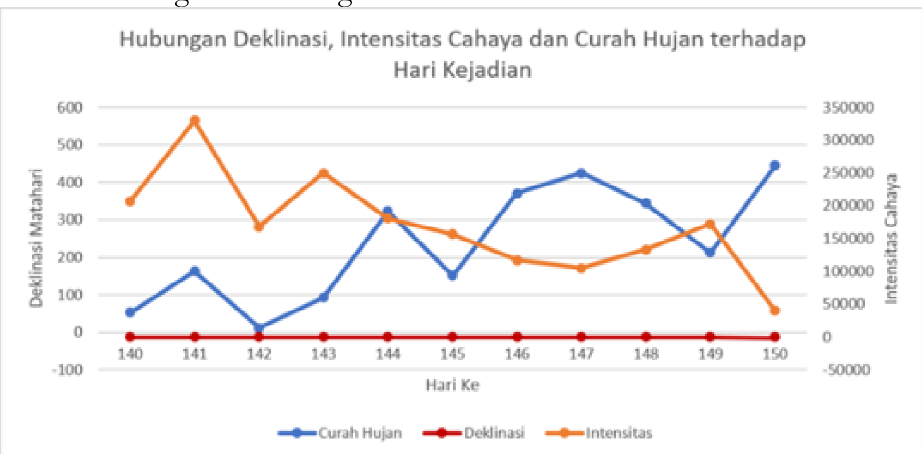


Figure 3. Graph of Solar Declination, Light Intensity to Rainfall with Occurrence Day

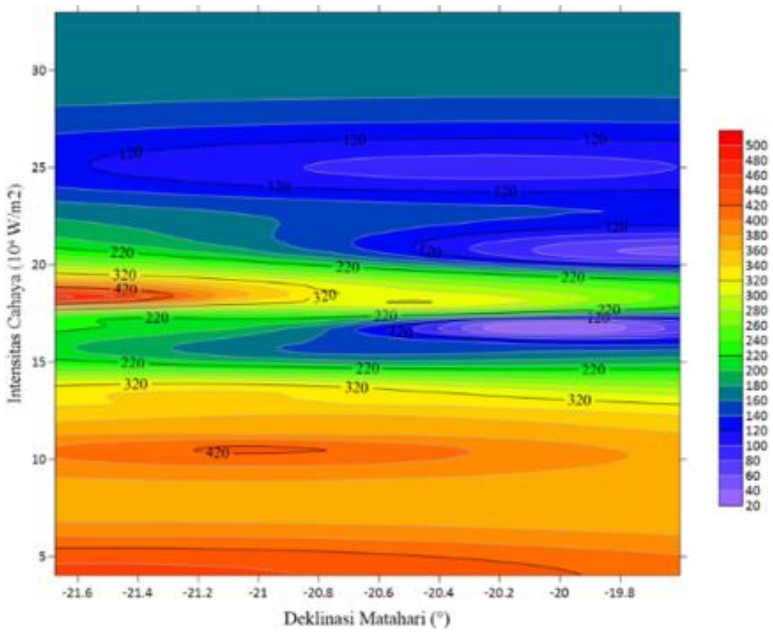


Figure 4. The contour of the relationship between the Sun's declination, light intensity, and rainfall observation period

The effect between the declination of the Sun and the intensity of light on precipitation is that the higher the precipitation, the lower the declination of the Sun and the lower the light intensity. It can be seen that on November 26, 2025, when the declination is around -21.3°, the intensity of light is in the range of (160,000–180,000)W/m², and the rainfall increases to about (200–220)mm. This coincided with the flash flood in East Malalak (Agam), which resulted in dozens of houses being damaged, casualties, and around 135 families displaced. In addition, on November 27, 2025, the Sun's declination was around -21.5°, the light intensity decreased in the range (40,000–50,000)W/m², and rainfall increased to about (430–450)mm. On that day, flash floods spread to Koto Aia, Koto Tangah (Padang), Palembayan (Agam), and Jembatan Kembar (Padang Panjang). In addition, on November 28, 2025, the Sun's altitude dropped to about -21.7°, and the amount of rain increased to about (480–500) mm. On that day, several areas in East Malalak were still impassable due to damaged road access.

The results of the Spearman correlation test showed that the declination of the Sun had a negative relationship with rainfall ($\varrho = -0.288$) with a significance level ($p < 0.05$), so it was included in the category of a weak relationship. These results show that the more negative the declination of the Sun, the more precipitation tends to increase. However, the relationship is relatively small, so the declination of the Sun cannot be considered a major factor in the occurrence of extreme rainfall. This shows that changes in the apparent position of the Sun play a greater role in influencing the distribution of radiation energy, which is further influenced by various atmospheric processes before finally producing rainfall.

In contrast, light intensity showed a negative relationship with rainfall ($\varrho = -0.428$) with a significance level ($p < 0.05$) that fell into the category of moderate relationships. A decrease in the intensity of light received by the surface generally occurs when cloud cover increases, so that the solar radiation reaching the surface becomes smaller. This condition is related to the process of forming convective clouds that support the occurrence of high-intensity rain. However, the strength of the relationship in the moderate category suggests that light intensity cannot yet be used as a single variable to predict extreme rainfall and still needs to be combined with other meteorological parameters, such as air humidity, air pressure, air temperature, and cloud cover.

Thus, the results of this study show that the relationship obtained is a statistical relationship, not a direct cause-and-effect relationship. The formation of extreme rain in West Sumatra is the result of the interaction of various local and global atmospheric factors, so that the declination of the Sun and light intensity are only some of the factors that affect these conditions.

Uji Kolerasi Deklinasi dan Intensitas Cahaya Terhadap Curah Hujan

			Deklinasi Matahari	Intensitas Cahaya	Curah Hujan
Spearman's rho	Deklinasi Matahari	Correlation Coefficient	1.000	.021	-.288**
		Sig. (2-tailed)	.	.774	<.001
		N	184	184	154
	Intensitas Cahaya	Correlation Coefficient	.021	1.000	-.428**
		Sig. (2-tailed)	.774	.	<.001
		N	184	185	154
	Curah Hujan	Correlation Coefficient	-.288**	-.428**	1.000
		Sig. (2-tailed)	<.001	<.001	.
		N	154	154	154

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 5. Correlation Test of Solar Declination and Light Intensity to Rainfall

Figure 5 presents the results of the Spearman's rho correlation test between solar declination, sunlight intensity, and rainfall. The results indicate a negative and statistically significant correlation between solar declination and rainfall, with a correlation coefficient of -0.288 ($p < 0.001$, N = 154). According to Guilford's classification, this value falls within the weak correlation category, suggesting that although lower solar declination values tend to be associated with higher rainfall totals, the relationship is not particularly strong. Meanwhile, sunlight intensity shows a stronger negative and significant correlation with rainfall, with a correlation coefficient of -0.428 ($p < 0.001$, N = 154), which falls within **the** moderate correlation category. This indicates that decreased sunlight intensity is more closely associated with increased rainfall occurrence compared to solar declination. In contrast, the correlation between solar declination and sunlight intensity was found to be very weak and statistically insignificant ($r = 0.021$, $p = 0.774$, N = 184), indicating a negligible relationship between the two variables and suggesting that they act relatively independently of one another.

CONCLUSION

The results showed that the declination of the Sun had a negative relationship with rainfall in the weak category ($\rho = -0.288$ and $p < 0.05$), while light intensity had a negative relationship in the moderate category ($\rho = -0.428$ and $p < 0.05$). This study shows that changes in the apparent position of the Sun are not directly related to extreme rainfall events, but through changes in the distribution of radiation energy which are then influenced by atmospheric processes. On the other hand, light intensity is more reflective of atmospheric conditions, especially the increase in cloud cover that favors the formation of rain.

Thus, light intensity has the potential to be used as a supporting parameter in the analysis of atmospheric conditions when combined with other meteorological parameters, but it cannot be used as a single indicator to predict extreme rainfall events. The findings of this study are expected to be additional information for BMKG in improving the analysis of weather conditions and supporting BPBD in creating an early warning system for the potential for extreme rain in West Sumatra. Follow-up research with wider data coverage, involving multiple observation stations, longer observation periods, and considering the influence of ENSO, IOD, and MJO, is needed to gain a more comprehensive understanding of the factors influencing extreme rainfall events.

ACKNOWLEDGMENT

The author would like to thank the Class II Minangkabau Padang Pariaman Meteorological Station for the support, cooperation, and provision of the data needed during the implementation of the research. The assistance provided is a very meaningful contribution so that this research can be carried out and completed properly.

REFERENCES

[1] A. Octavianti, Muliadi, and Apriansyah, "Estimation of Solar Radiation Intensity in the Makassar City Area," *Prism. Fis.*, vol. 6, no. 3, pp. 152–159, 2018.

[2] BMKG, "Prediction of the 2025/2026 Rainy Season in Indonesia (November 2025 Update)," Rini Eka Saputri. [Online]. Available: https://www.bmkg.go.id/iklim/prediksi-

musim/prediksi-musim-hujan-2025-2026-di-indonesia-pemutakhiran-november-2025
[3] BNPB, "Indonesian Disaster Data 2024–2025," 2025.
[4] J. Dekriani, L. Dwiridal, H. Amir, and Zulhendra, "Effect of Declination and Solar Radiation Intensity on Weather Parameters in 2020-2023 in Padang City," *Bull. Fig.*, vol. 26, no. 1, pp. 30–38, 2025, doi: 10.24843/BF.2025.v26.i01.p04.
[5] M. J. Fadhilah and A. Mulya, "Analysis of Atmospheric Dynamics and Identification of Convective Cloud Distribution Using the RGB Method on Himawari-8 Satellite Imagery Related to Floods in Jayawijaya Regency, Wamena (Case Study: Period 9 March 2021)," *J. Tek. SILITEK*, vol. 1, no. 02, pp. 121–134, 2022, doi: 10.51135/jts.v1i02.17.
[6] E. Penawan, R. S. Z, and R. Khairati, "Mapping West Sumatra Based on the Main Source of Community Income with a Regional Characteristics Approach," *J. Socio Econ. Too much. Agric. (Jurnal Sos. Ekon. Pertan. Too much.*, vol. 7, no. 1, pp. 12–19, 2025, doi:10.25077/joseta.v7i1.617.
[7] Suggestion, *Qualitative Quantitative Research and R&D Methods*, 19th ed. Bandung: Alfabeta, cv, 2013.
[8] A. Sasmito, A. S. Praja, L. F. Muzayanah, and R. S. Sudewi, "The Effect of Solar Declination on Weather Parameters in Malang and Its Surroundings," *Indones. J. Appl. Phys.*, vol. 11, no. 2, pp. 164–175, 2021.
[9] S. Ali, T. M. A. Pandria, D. Teknik, M. Universitas, and T. Umar, "Determination of the Optimal Tilt Angle of Solar Panels for the Meulaboh Area," *J. Mekanova*, vol. 5, no. 1, pp. 21–29, 2019, doi: 10.35308/jmkn.v5i1.1621.
[10] NOAA, "NOAA Solar Calculator," National Oceanic and Atmospheric Administration, 2025. Accessed: May 20, 2026. [Online]. Available: https://gml.noaa.gov/grad/solcalc/
[11] M. Guo, D. She, L. Zhang, L. Li, Z.-L. Yang, and S. Hong, "Attribution of trends in meteorological drought during 1960–2016 over the Loess Plateau, China," *J. Geogr. Sci.*, vol. 31, no. 8, pp. 1123–1139, 2021, doi: 10.1007/s11442-021-1888-y.
[12] World Meteorological Organization, *Guide to Instruments and Methods of Observation*. in WMO-No. 8. Geneva, Switzerland: World Meteorological Organization, 2021. [Online]. Available: https://library.wmo.int/
[13] F. Chiang, O. Mazdiyasni, and A. AghaKouchak, "Evidence of anthropogenic impacts on global drought frequency, duration, and intensity," *Nat. Commun.*, vol. 12, no. 2754, pp. 1–10, 2021, doi: 10.1038/s41467-021-22314-w.
[14] M. L. Tan, L. Juneng, H. Kuswanto, and H. X. Do, "Impacts of Solar Radiation Management on Hydro-Climatic Extremes in Southeast Asia," *Water*, vol. 15, no. 6, p. 1089, 2023, doi: 10.3390/w15061089.
[15] E. Febrinal, "AWS Solar Radiation Data Digitization of Minangkabau Meteorology Station - Padang Pariaman."
[16] J. Pinos and A. Quesada-román, "Flood Risk-Related Research Trends in Latin America and the Caribbean," *Water*, vol. 14, no. 10, pp. 1–14, 2022, doi: 10.3390/w14010010.
[17] E. C. O. L. De *et al.*, "Precipitation forecasting : from geophysical aspects to machine learning applications," *Front. Air conditioning.*, vol. 5, 2023, doi: 10.3389/fclim.2023.1250201.
[18] H. J. Fowler and H. Ali, "Chapter 11 - Analysis of extreme rainfall events under the climatic change," in *Rainfall*, R. Morbidelli, Ed., Elsevier, 2022, pp. 307–326. doi: https://doi.org/10.1016/B978-0-12-822544-8.00017-2.
[19] BMKG, "Aplikasi Data Online," 2024. Accessed: Jun. 20, 2026. [Online]. Available: https://dataonline.bmkg.go.id/dataonline-home
[20] J. D. Gibbons and S. Chakraborti, *Nonparametric Statistical Inference, Fifth Edition*. Taylor \& Francis, 2010. [Online]. Available: https://books.google.co.id/books?id=Xhm4IgAACAAJ