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WORD COUNT 4184
TIME SUBMITTED 03-JUN-2024 12:46PM
PAPER ID 109388636

BAREKENG: Journal of Mathematics and Its Applications
March 2022 Volume xx Issue xx Page xxx–xxx
P-ISSN: 1978-7227 E-ISSN: 2615-3017
https://doi.org/10.30598/barekengxxxxxxxxxxxxx

DYNAMICS OF RAINFALL AND TEMPERATURE IN NORTH SUMATERA PROVINCE: COMPREHENSIVE ANALYSIS OF TEMPORAL TRENDS

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Article History:
Received: date, month year
Revised: date, month year
Accepted: date, month year

Keywords:
Trend Analysis;
Rainfall;
Temperature;
North Sumatra

ABSTRACT

This research aims to analyze the temporal trends of rainfall and temperature in the North Sumatera Province, with a focus on the Medan and Deli Serdang regions. The methods employed include the Mann-Kendall test to identify trends in rainfall and temperature data, Sen's Slope Estimator to measure the slope of trends, and Pearson correlation analysis to understand the relationship between rainfall and temperature. The results of this research are expected to provide a better understanding of climate change and its impacts on weather conditions in this region. Data analysis indicates that Medan has higher monthly rainfall compared to Deli Serdang. There is a significant increase of trend in rainfall in both regions, although the increase is not very steep. Additionally, there is a positive relationship between monthly rainfall and temperature in both areas, although this relationship is not very strong. The analysis of temperature data shows a significant increasing trend. These findings have important implications for the government, research institutions, and the community in developing climate change adaptation and mitigation strategies. With a better understanding of climate change trends and their relationship with rainfall and temperature, appropriate measures can be taken to address potential future impacts.

How to cite this article:

First author, second author, etc., "TITLE OF ARTICLE," *BAREKENG: J. Math. & App.*, vol. xx, iss. xx, pp. xxx-xxx, Month, Year.

Journal homepage: *https://ojs3.unpatti.ac.id/index.php/barekeng/*
Journal e-mail: *barekeng.math@yahoo.com; barekeng.journal@mail.unpatti.ac.id*
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1. INTRODUCTION

Climate change has emerged as a pressing concern worldwide [1][2], evidenced by alterations in global temperatures, precipitation patterns, and increasing occurrences of extreme weather events such as floods and droughts [3][4]. Particularly in Indonesia, the fluctuating climate has significantly influenced both rainfall and temperature across various locales [5][6], including Medan and Deli Serdang..

Climate change can lead to significant fluctuations in rainfall [7][8] and temperature [9][10] in the region, which, in turn, affect crucial sectors such as agriculture [11], the environment [12], and the daily lives of local residents [13]. Altered rainfall patterns can also impact the water cycle [14], soil salinity [15], as well as the sustainability of river ecosystems [16] and forests [17]. Therefore, a profound understanding of the trends in climate change and the relationship between rainfall and temperature in Medan and Deli Serdang becomes crucial.

This study will use the Mann-Kendall method to identify trends in rainfall [18] and temperature [19] data over the past several years. Additionally, the Sen's Slope Estimator method [20] will be employed to measure the slope of these trends. To further enhance understanding, a correlation analysis [21] will be conducted to explore the relationship between rainfall and temperature.

By conducting this study, we aim to provide a comprehensive understanding of the implications of climate change on weather patterns and their consequential effects on local and global scales. This knowledge will assist policymakers, institutions, and local communities in crafting effective strategies for adapting to and mitigating the impacts of climate change, ensuring more sustainable management of natural resources..

2. RESEARCH METHODS

The Mann-Kendall method, Kendall Tau, Sen's Slope, and Pearson correlation will be used to analyze rainfall and temperature in the North Sumatera region. The data will be obtained from the Central Statistics Agency of North Sumatera (BPS Sumut) specifically from the social and population section that includes climate information, covering the period from January 2000 to December 2022. The Mann-Kendall method will identify significance as well as increases or decreases in the data. Kendall Tau will measure the extent of the relationship between rainfall or temperature over time. The Sen's Slope will calculate the rate of average change in rainfall and temperature. In the final stage, the correlation between temperature and rainfall in each region will be calculated using the Pearson correlation method.

2.1 Mann Kendall

The Mann-Kendall test stands out as a robust statistical method designed to identify trends in time series data [22]. It achieves this through the computation of a specific statistic, known as S. This statistic is derived by systematically evaluating the differences between all possible pairs of data points within the series. The calculation is expressed through the equation::

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} sgn(x_j - x_k) \quad (1)$$

Here, the function sgn plays a critical role. It examines the difference between each pair of data points, x_j and x_k, assigning a value based on their relative magnitude. This results in a comprehensive summation that reflects the overall direction and strength of the trend across the dataset.

The $sgn(\theta)$ value, where N is the number of data points and $x_j - x_k = \theta$, can be observed as follows:

$$sgn = \begin{cases} 1\ if\ (x_j - x_k) > 0 \\ 0\ if\ (x_j - x_k) = 0 \\ -1\ if\ (x_j - x_k) < 0 \end{cases} \quad (2)$$

This test is notably effective when applied to larger data sets (N > 10), and the variance of the S statistic can be accurately computed, providing a robust measure of trend detection in the time series data.

$$Var(S) = \frac{n(n-1)(2n+5) - \sum_{j=1}^{m} t_j(t_j-1)(2t_j+5)}{18} \quad (3)$$

In the realm of time series analysis, the presented formula outlines the process for calculating the total number of data points, denoted as n. The variable m stands for the number of groups containing data points that share identical values. These groups are referred to as "tied groups." Each tied group's size is represented by t_j, indicating how many data points belong to the j-th group. For the variance of the S statistic, the formula takes into account the overall data point count n, the number of tied groups m, and the size of each of these groups.

$$Z_{MK} = \begin{cases} \frac{S-1}{\sqrt{Var(S)}}\ if\ S > 0 \\ 0\ if\ S = 0 \\ \frac{S+1}{\sqrt{Var(S)}}\ if\ S < 0 \end{cases} \quad (4)$$

The Z_{MK} statistic, which follows a standard normal distribution with a mean of zero and a unit variance, is computed based on the value of S. If S is positive, Z_{MK} is calculated using the square root of the variance of S. If S is a zero, then Z_{MK} is zero. For negative S, a similar calculation is conducted but with a different denominator. The hypothesis under investigation is assessed using a confidence interval of 95%. Should the Z-score be positive, it signifies a rising trend, whereas a negative Z-score suggests a decline. When the P value falls below 0.05, it affirms that the observed trend is statistically significant, meeting the 95% confidence threshold.

2.2 Sen's Slope Estimator

The Sen's Slope Estimator is a robust method used to ascertain the rate of change in trends [23], particularly in climate-related datasets such as temperature and rainfall. It computes the slope, β, of a trend line by finding the median of all slopes calculated from the dataset pairs. This is articulated through the formula:

$$\beta = median\left(\frac{x_j - x_k}{j-k}\right) \quad (5)$$

Where x_j and x_k are the measurements at times j and k correspondingly, and $j > k$. This approach ensures a resistant estimate that is less affected by outliers in the data. The calculation of the quantile Q_1 depends on whether the number of observations N is odd or even:

$$Q_i = \begin{cases} T_{\frac{N-1}{2}} & N\ is\ odd \\ \frac{1}{2}T_{\frac{N}{2}+\frac{N+2}{2}} & N\ is\ even \end{cases} \quad (6)$$

The sign of Q_1 is indicative of the trend direction, where a positive Q_1 signals a long-term upward trend and a negative Q_1, a downward trend. Following the determination of the slope β, it is utilized to construct the trend line equation:

$$Y_t = \beta.t + X_t \quad (7)$$

In this equation, Y_t represents the estimated value predicted by the trend line for time t, and X_t is the intercept, representing the starting point of the trend line on the y-axis. This method provides a systematic approach to understanding and predicting changes in environmental data over time, aiding in decision-making related to climate adaptation and resource management strategies

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2.3 Kendall Tau

Kendall's Tau is a non-parametric statistical measure used to assess the strength and direction of the association between two variables [24], such as rainfall or temperature. This statistic is valuable in identifying how closely these variables move together, indicating either a positive or negative correlation. The calculation of Kendall's Tau is represented by the formula:

$$\tau = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} sgn(x_i - x_j)\, sgn(y_i - y_j)}{n(n-1)} \quad (8)$$

Where sgn is a sign function applied to the differences between the paired data points x_i and x_j, as well as y_i and y_j. This function outputs 1 when the difference is positive, -1 when negative, and 0 when there is no difference,

$$sgn(x_i - x_j) = \begin{cases} 1 \; if \; (x_i - x_j) > 0 \\ 0 \; if \; (x_i - x_j) = 0 \\ -1 \; if \; (x_i - x_j) < 0 \\ sgn(y_i - y_j) \end{cases} = \begin{cases} 1 \; if \; (y_i - y_j) > 0 \\ 0 \; if \; (y_i - y_j) = 0 \\ -1 \; if \; (y_i - y_j) < 0 \end{cases} \quad (9)$$

Kendall's Tau effectively captures both concordant and discordant pairs. Concordant pairs occur when both elements in one pair are either larger or smaller than those in the other pair, indicating that the variables change in the same direction. Discordant pairs, where the elements of the pair move in opposite directions, suggest an inverse relationship. The absolute value of Kendall's Tau, ranging from 0 to 1, reflects the strength of the monotonic relationship between the two variables higher values denote stronger correlations. A positive Tau value indicates a direct relationship, while a negative value points to an inverse correlation.

2.4 Pearson Correlation

The Pearson correlation coefficient, symbolized as r_p, is an essential statistical tool that evaluates both the strength and the directional correlation between two variables that have a linear relationship [21], such as rainfall and temperature. This coefficient provides a numerical indicator that ranges from -1 to 1, where each extreme reflects a perfect inverse or direct linear relationship, respectively, and a zero value denotes no linear correlation at all.

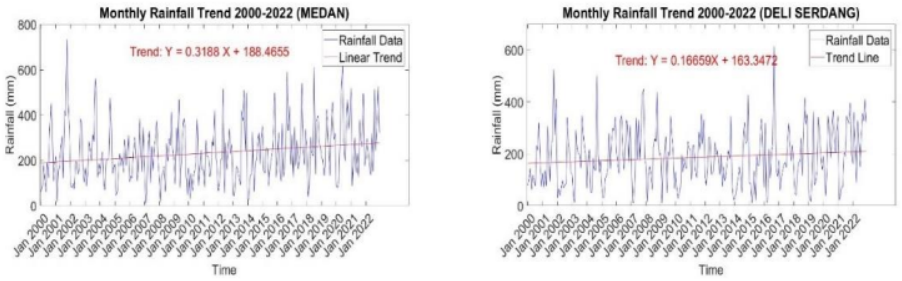
The computation of r_p involves a formula that systematically measures how much two variables vary together compared to how much they vary individually:

$$r_p = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{(\sum(X_i - \bar{X})^2)(\sum(Y_i - \bar{Y})^2)}} \quad (10)$$

In this equation, X_i and Y_i represent the individual observations of variables X and Y, while $\bar{X}$ and $\bar{Y}$ are their respective means. This formula effectively normalizes the product of the deviations of each variable from its mean, providing a scale of correlation that is easy to interpret in terms of statistical significance and real-world relevance. This method is particularly useful in quantifying the linear relationships in data where both variables are assumed to follow a normal distribution and are measured on an interval scale.

3. RESULTS AND DISCUSSION

3.1. Rainfall Trend



(a) (b)

Figure 1. Rainfall Trend Analysis using Mann-Kendall (a) Medan (b) Deli Serdang

Table 1. MK Test Results for Values, Mean, Median, and Change Points of Rainfall Data for the Study Area.

Area	Mean	Median	Mann Kendall Test		Tau Value	Slope Value
			Z-Value	P-Value		
Medan	232.62	206	3.5125	0.00044397	0.14187	0.95345
Deli Serdang	186.41	175.5	2.1415	0.03223	0.086509	0.87273

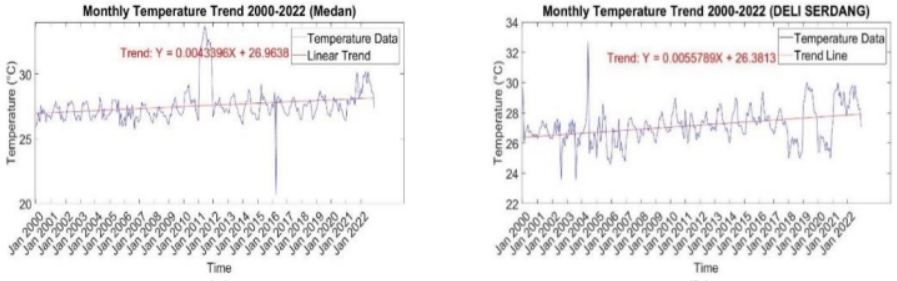
***Data source**: The Data Was Processed Using Matlab*

As can be seen in Table 1, the results of the rainfall data analysis for Medan and Deli Serdang regions also reveal important information. The average monthly rainfall for Medan is around 232.62 mm, while for Deli Serdang, it is approximately 186.42 mm. This difference indicates that Medan tends to have higher monthly rainfall compared to Deli Serdang. Furthermore, the Mann-Kendall test yields interesting results, where by substituting Eq. (4), the Z-Value is approximately 3.5125 for Medan and 2.1415 for Deli Serdang, with P-Values of about 0.00044397 and 0.03223, respectively. This indicates the presence of significant trends in rainfall data in both regions. Medan shows a stronger increasing trend compared to Deli Serdang, reflecting significant changes in rainfall.

Additionally, Kendall Tau analysis for both regions indicate a positive correlation between rainfall and temperature. Using Eq. (8), the Kendall Tau approximately about 0.14187 for the city of Medan, while Deli Serdang has a value of about 0.086509. This suggests a positive relationship between monthly rainfall and temperature in both regions. Although this relationship may not appear very strong, the positive Kendall Tau values indicate that when rainfall increases, temperatures tend to rise, and vice versa. This information can be valuable in understanding regional climate patterns and their impacts on society and the environment.

Finally, utilizing Eq. (7), the slope values in the rainfall data indicate trends in changes in rainfall over time. Medan has a slope value of about 0.95345, while Deli Serdang has a value of around 0.87273. This indicates that both regions show an increasing trend in rainfall, as can be seen in Figure 1. However, it is important to note that the increase is not very steep. This information is crucial for water resource planning, flood management, and adaptation to changes in rainfall patterns in this area.

3.2. Temperature Trend



(a) (b)

Figure 2. Temperature Trend Analysis Using Mann-Kendall (a) Medan (b) Deli Serdang

Table 2. MK Test Results For Values, Mean, Median, and Change Points of Temperature for the Study Area

Area	Mean	Median	Mann Kendall Test		Tau Value	Slope Value
			Z-Value	P-Value		
Medan	27.56	27.3	6.638	$3.1798e^{-11}$	0.26809	0.0054545
Deli Serdang	27.15	27.05	6.5819	$4.6454e^{-11}$	0.26582	-0.0094545

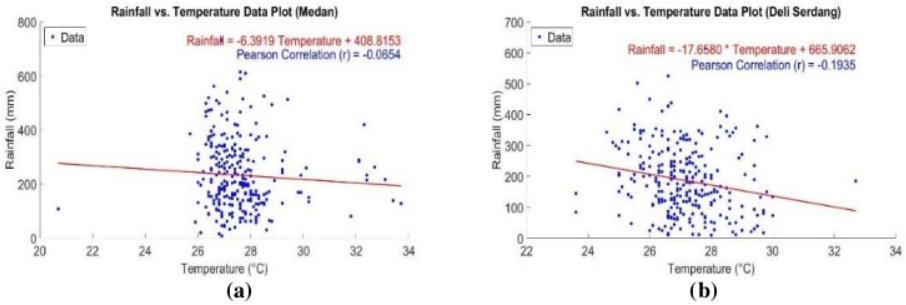
***Data source**: The Data Was Processed Using Matlab*

As can be seen in Table 2, the analysis of temperature data for Medan and Deli Serdang regions reveals significant findings. The average monthly temperature for Medan is around 27.56 °C, while for Deli Serdang, it is approximately 27.15 °C. By substituting Eq. (4), the Mann-Kendall test results show a Z-Value of 6.638 with a very low P-Value, approximately $3.1798e^{-11}$ for Medan, and a Z-Value of about 6.5819 with a P-Value of $4.6454e^{-11}$ for Deli Serdang. This indicates a highly significant increasing trend in temperature in both regions over a specific period. However, it is important to note that, although the increasing temperature trend is detected, the rate of increase is very small.

Furthermore, in the Kendall Tau analysis which utilizes by Eq. (8), Medan has a Kendall Tau value of 0.26809, while Deli Serdang has a value of 0.26582. This indicates a positive correlation between rainfall and temperature in both regions. However, it is noteworthy that the higher Kendall Tau value for Medan indicates a stronger correlation compared to Deli Serdang.

Finally, utilizing Eq. (7), the slope value, which reflects the steepness of the trend in temperature data, indicates a very slight increase in temperature over time. Medan has a slope value of about 0.0054545, while Deli Serdang has a value of around -0.0094545. Although a significant increasing trend in temperature is detected, the very small slope values suggest that the increase is only marginal each year, as can be seen in Figure 2. This information is crucial for understanding climate change in both regions and can assist in planning climate change adaptation for the future.

3.3. Correlation of Rainfall with Temperature



(a) (b)

Figure 3. Correlation Analysis Between Rainfall and Temperature (a) Medan (b) Deli Serdang

Table 3. Pearson Correlation Results

Area	Pearson Correlation (r)
Medan	-0.0654
Deli Serdang	-0.1935

***Data source**: The Data Was Processed Using Matlab*

By using eq. (10) the results of the Pearson correlation analysis between rainfall and temperature in Medan region show that the correlation coefficient (r) is approximately -0.0654, as can be seen in Table 3. This indicates a weak and negative relationship between monthly rainfall and temperature in Medan region. In other words, when rainfall increases, the temperature tends to slightly decrease, and vice versa. Although this correlation is negative, its value is very close to zero, indicating that there is no significant relationship between these two variables in this region.

Meanwhile, the results of the Pearson correlation for Deli Serdang indicate a value of -0.1935. This suggests a slightly stronger negative correlation between monthly rainfall and temperature in Deli Serdang region. Although this correlation is also negative, its value still falls within the weak range, indicating that changes in rainfall only slightly affect temperature changes in this region.

Based on Figure 3, temperature does not significantly influence the rainfall pattern in Medan, at least for the dataset used in this analysis. This can be observed from the very low correlation coefficient and the relatively wide distribution of data in the graph.

4. CONCLUSION

Based on the analysis of rainfall and temperature data in North Sumatera Province, particularly in the Medan and Deli Serdang regions, several important findings have been identified. First, there is a trend of increasing monthly rainfall in both regions, although the increase is not very steep. Medan experiences higher monthly rainfall compared to Deli Serdang. Second, there is a positive relationship between monthly rainfall and temperature in both regions, although the relationship is not very strong. Third, there is a significant increasing trend in temperature in both regions, although the rate of increase is very small. These findings have important implications for addressing climate change in North Sumatera Province. The government, research institutions, and the community need to develop appropriate adaptation and mitigation strategies to cope with the potential impacts of climate change in the future.

REFERENCES

[1] E. Vanem, "Joint statistical models for significant wave height and wave period in a changing climate," *Mar. Struct.*, vol. 49, pp. 180–205, 2016, doi: 10.1016/j.marstruc.2016.06.001.

[2] P. Zhu, Z. (Justin) Zhang, and B. Lin, "Understanding spatial evolution of global climate change risk: Insights from convergence analysis," *J. Clean. Prod.*, vol. 413, no. November 2022, p. 137423, 2023, doi: 10.1016/j.jclepro.2023.137423.

[3] S. Yang *et al.*, "Future changes in water resources, floods and droughts under the joint impact of climate and land-use changes in the Chao Phraya basin, Thailand," *J. Hydrol.*, vol. 620, no. PA, p. 129454, 2023, doi: 10.1016/j.jhydrol.2023.129454.

[4] P. S. Fabian, H. H. Kwon, M. Vithanage, and J. H. Lee, "Modeling, challenges, and strategies for understanding impacts of climate extremes (droughts and floods) on water quality in Asia: A review," *Environ. Res.*, vol. 225, no. February, 2023, doi: 10.1016/j.envres.2023.115617.

[5] Arifah, D. Salman, A. Yassi, and E. Bahsar-Demmallino, "Climate change impacts and the rice farmers' responses at irrigated upstream and downstream in Indonesia," *Heliyon*, vol. 8, no. 12, p. e11923, 2022, doi: 10.1016/j.heliyon.2022.e11923.

[6] H. Kuswanto, F. Hibatullah, and E. S. Soedjono, "Perception of weather and seasonal drought forecasts and its impact on livelihood in East Nusa Tenggara, Indonesia," *Heliyon*, vol. 5, no. 8, p. e02360, 2019, doi: 10.1016/j.heliyon.2019.e02360.

[7] K. V. Subrahmanyam, M. V. Ramana, and P. Chauhan, "Long-term changes in rainfall epochs and intensity patterns of Indian summer monsoon in changing climate," *Atmos. Res.*, vol. 295, no. April, p. 106997, 2023, doi: 10.1016/j.atmosres.2023.106997.

[8] S. O'Neill, S. F. B. Tett, and K. Donovan, "Extreme rainfall risk and climate change impact assessment for Edinburgh World Heritage sites," *Weather Clim. Extrem.*, vol. 38, no. October 2021, p. 100514, 2022, doi: 10.1016/j.wace.2022.100514.

[9] V. Grey, K. Smith-miles, T. D. Fletcher, B. Hatt, and R. Coleman, "Empirical evidence of climate change and urbanization impacts on warming stream temperatures," *Water Res.*, p. 120703, 2023, doi: 10.1016/j.watres.2023.120703.

[10] V. L. Diengdoh, S. Ondei, M. Hunt, and B. W. Brook, "Predicted impacts of climate change and extreme temperature events on the future distribution of fruit bat species in Australia," *Glob. Ecol. Conserv.*, vol. 37, no. January, p. e02181, 2022, doi: 10.1016/j.gecco.2022.e02181.

[11] W. C. S. M. Abeysekara, M. Siriwardana, and S. Meng, "Economic consequences of climate change impacts on the agricultural sector of South Asia: A case study of Sri Lanka," *Econ. Anal. Policy*, vol. 77, pp. 435–450, 2023, doi: 10.1016/j.eap.2022.12.003.

[12] L. Wu *et al.*, "Impact of extreme climates on land surface phenology in Central Asia," *Ecol. Indic.*, vol. 146, no. June 2022, p. 109832, 2023, doi: 10.1016/j.ecolind.2022.109832.

[13] A. P. Barreira, J. Andraz, V. Ferreira, and T. Panagopoulos, "Perceptions and preferences of urban residents for green infrastructure to help cities adapt to climate change threats," *Cities*, vol. 141, no. July, p. 104478, 2023, doi: 10.1016/j.cities.2023.104478.

[14] L. Tanika, C. Wamucii, L. Best, E. G. Lagneaux, M. Githinji, and M. van Noordwijk, "Who or what makes rainfall? Relational and instrumental paradigms for human impacts on atmospheric water cycling," *Curr. Opin. Environ. Sustain.*, vol. 63, p. 101300, 2023, doi: 10.1016/j.cosust.2023.101300.

[15] J. Han *et al.*, "Synergistic effect of climate change and water management: Historical and future soil salinity in the Kur-Araz lowland, Azerbaijan," *Sci. Total Environ.*, vol. 907, no. July 2023, p. 167720, 2024, doi: 10.1016/j.scitotenv.2023.167720.

[16] R. Tang, Z. Dai, X. Mei, X. Zhou, C. Long, and C. M. Van, "Secular trend in water discharge transport in the Lower Mekong River-delta: Effects of multiple anthropogenic stressors, rainfall, and tropical cyclones," *Estuar. Coast. Shelf Sci.*, vol. 281, no. January, p. 108217, 2023, doi: 10.1016/j.ecss.2023.108217.

[17] R. Fischer, A. Armstrong, H. H. Shugart, and A. Huth, "Simulating the impacts of reduced rainfall on carbon stocks and net ecosystem exchange in a tropical forest," *Environ. Model. Softw.*, vol. 52, pp. 200–206, 2014, doi: 10.1016/j.envsoft.2013.10.026.

[18] E. B. I. Ugwu, D. O. Ugbor, J. U. Agbo, and A. Alfa, "Analyzing rainfall trend and drought occurences in Sudan Savanna of Nigeria," *Sci. African*, vol. 20, 2023, doi: 10.1016/j.sciaf.2023.e01670.

[19] Y. S. Getahun, M. H. Li, and I. F. Pun, "Trend and change-point detection analyses of rainfall and temperature over the Awash River basin of Ethiopia," *Heliyon*, vol. 7, no. 9, p. e08024, 2021, doi: 10.1016/j.heliyon.2021.e08024.

[20] M. Shawky *et al.*, "Remote sensing-derived land surface temperature trends over South Asia," *Ecol. Inform.*, vol. 74, no. November 2022, p. 101969, 2023, doi: 10.1016/j.ecoinf.2022.101969.

[21] M. A. Fattah *et al.*, "Spatiotemporal characterization of relative humidity trends and influence of climatic factors in Bangladesh," *Heliyon*, vol. 9, no. 9, p. e19991, 2023, doi: 10.1016/j.heliyon.2023.e19991.

[22] M. Higashino, T. Hayashi, and D. Aso, "Temporal variability of daily precipitation concentration in Japan for a century: Effects of air temperature rises on extreme rainfall events," *Urban Clim.*, vol. 46, no. April, p. 101323, 2022, doi: 10.1016/j.uclim.2022.101323.

[23] S. Rashid Abubaker and R. Othman Ali, "Trend analysis using mann-kendall, sen's slope estimator test and innovative trend analysis method in Yangtze river basin, china: review," *Int. J. Eng. &Technology*, vol. 8, no. 2, pp. 110–119, 2019, doi: 10.14419/ijet.v7i4.29591.

[24] S. Nath, A. Mathew, S. Khandelwal, and P. R. Shekar, "Rainfall and temperature dynamics in four Indian states: A comprehensive spatial and temporal trend analysis," *HydroResearch*, vol. 6, pp. 247–254, 2023, doi: 10.1016/j.hydres.2023.09.001.

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