Reveals of a Shifting Climate: A Regional Analysis of Rainfall and Temperature Trends at Mymensingh Division in Bangladesh (1950-2020)

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Abstract

Professional resource allocation and planning in response to climate change in developing regions such as the Mymensingh Division of Bangladesh requires comprehension of trends in temperature and precipitation over long periods of forecast. This is the reason why this study examines the temperature and precipitation from the years 1950 to 2020 in order to provide a reasonable view of local climatic conditions and facilitate the policymaking process. By using climactic research unit (CRU) TS data sets in creation of raster layers using ArcGIS tools we undertook data processing research which involved statistical analysis methods. Mann-Kendall test has generated a very encouraging result as it has found relative increase in annual precipitation, averaging about 2760.52 mm and oscillating between 1752 mm and 4338 mm. Kendall's tau correlation $\tau = 0.156$, p-value = 0.024, shows a possible change over a period of time. Slope of sen demonstrated that precipitation regime has increase by 1.9 mm annually. The analyses of autocorrelation and partial autocorrelation confirmed that the precipitation data upside and trends are clearly delineated. Progressive warming trend as regards the average annual temperature was observed, as the years went by, the average annual temperature increased from 24.77 0 c to 25.170c, more so in recent years where there have been high degree of warming. This study highlights the need for ongoing climate and the enhancement of global warming policies to prevent worsening situations.

Introduction

Climate change represents a significant global challenge, particularly affecting nations that are still developing. The parameters of temperature and precipitation are fundamental elements that shape ecological systems, with their fluctuations exerting a profound influence on climatic patterns. It is imperative to comprehend the long-term trajectories of these elements for the effective management of hydrological resources, strategic agricultural planning, and adaptation to the ramifications of climate change (Mohd Wani et al. 2017; Alemayehu et al. 2020). The formulation of effective adaptation strategies necessitates a thorough examination of long-term trends and extremes in regional climatic variables (Atube et al. 2022). In the Mymensingh Division of Bangladesh, the analysis of temperature trends over prolonged durations is essential, given the region's economic importance.Projections indicate that global surface temperatures may increase by 1.4 to 5.8°C between 1990 and 2100, with possible escalations of 1.5°C to over 2.0°C by the century's conclusion (Alam et al. 2023).A comprehensive understanding of these patterns is vital for promoting sustainable agricultural practices, effective disaster management, and climate adaptation strategies in Bangladesh. The impacts of climate change are heterogeneous, influenced by geographic and socioeconomic variables. Anticipated future climatic effects may heighten the frequency and intensity of floods and droughts, with temperature increases projected to range from 3 to 4°C (Esayas et al. 2018). The variability in precipitation, influenced by both natural and anthropogenic factors, has significant implications for water resources, agricultural productivity, and ecosystems.Such variability complicates efforts in water management and mitigation strategies (Ahmad et al. 2022).Historical analyses of precipitation trends reveal increases in areas such as eastern North America and northern Europe, whereas declines have been recorded in the Sahel, Mediterranean region, and southern Asia (Odedra and Jadeja 2023). Rainfall patterns exhibit substantial temporal and spatial variability, driven by seasonal atmospheric alterations and geographic characteristics (Rani 2014). Detailed assessments of temperature and precipitation trends are vital for grasping and addressing the repercussions of climate change, in light of the interconnected characteristics of these phenomena and their global impacts.South Asia, including Bangladesh, experiences significant temperature variability, presenting challenges in identifying climate change and discerning its anthropogenic effects (Priyakumara and Ranasinghe 2023). Rising temperatures are projected to exacerbate challenges related to floods, droughts, and cyclones, with internal climatic fluctuations such as ENSO also contributing to flooding occurrences (Uddin et al. 2023). Comprehensive investigations of rainfall are crucial for effective water management and disaster preparedness. However, there exists a deficiency of localized studies addressing spatiotemporal rainfall variability within Bangladesh.Urban ecosystems deliver essential services, and their functionality is profoundly affected by climate change (Pandey and Ghosh 2023). Fluctuations in precipitation have a significant impact on food security, agricultural productivity, and the associated risks of droughts and floods.A report by the Asian Development Bank and the International Food Policy Research Institute (2009) identified Bangladesh as extremely susceptible to climate change, based on indicators related to alterations in temperature and precipitation, agricultural labor dynamics, and poverty levels (Billah et al. 2015). The challenge of addressing climate change necessitates localized analyses to facilitate informed decision-making and the development of effective adaptation strategies (Dadi et al. 2024).Alleviating the effects of climate change requires a cutback on local emissions, the implementation of greenhouse gas reduction strategies, and the enhancement of infrastructure resilience. Comprehension of regional climate variability and transitions is imperative for enhancing climate projections and formulating effective adaptation strategies. Employing statistical methodologies for the analysis of trends and variability in temperature and precipitation data is fundamental to this endeavor (Manglem 2021). Investigative research into temperature and precipitation fluctuations is crucial for urban areas that are experiencing the impacts of climate change (Balogun et al. 2023). This study is centered on the Mymensingh Division, scrutinizing long-term trends in temperature and precipitation from the year 1950 to 2020. It examines temperature patterns, analyzes the correlation between temperature and precipitation variability, and offers insights to inform policy and adaptation strategies in response to a dynamically changing climate.

Materials and Methods

Study Area

Mymensingh division is located in northern Bangladesh and is bordered by Meghalaya (India) to the north, the district Gazipur to the south, Netrokona and Kishoreganj districts to the east, and Sherpur, Jamalpur, and Tangail districts to the west. Mymensingh division is a metropolitan city of Bangladesh located on the bank of the old Brahmaputra River about 120 km north of the national capital city Dhaka. It lies on 24°45'14"N 90°24'11"E. Mymensingh Division covers an area of about 10,485 $(\text{kilometers})^2$ and it has a population of about 12,225,498. The division Mymensingh’s climate is closer to the Himalayan

Mountain that’s why their temperature is a little colder than the capital city Dhaka's temperature. Mymensingh occupies a Tropical wet and dry or savanna climate. The maximum amount of rainfall occurs during the monsoon season (May/June to August). The area falls under monsoon climatic repossess and annual temperature differs from 13ºC to 37ºC average monthly rainfall: January 12mm, June 469mm, December 2mm, and most the time total annual rainfall varies from 2000mm to 2500mm.

Data sources

CRU TS (Climatic Research Unit gridded Time Series) is a broadly used climate dataset on a 0.5° latitude by 0.5° longitude grid over all land domains over the world except Antarctica. It is extracted by the interpolation of monthly climate irregularities from extensive networks of weather station observations (Harris et al. 2020).

Data processing

The principle of the methodology lies in the application of certain ArcGIS tools. The "Make Net CDF Raster Layer" tool is used to create a raster layer from Net CDF files, while "Raster Processing" tools make possible the manipulation, editing, and management of raster data. To analyze cell values across multiple raster, the "Cell Statistics" tool is employed to derive statistical information. Besides, the "Inverse Distance Weighted (IDW)" tool comes into play for interpolating raster surfaces from point data using a reverse distance weighted technique. Following the application of these tools, the processed data is exposed to analysis and visualization, leveraging ArcGIS mapping and visualization capabilities to present the results in a relevant manner.

Rainfall Pattern Analysis with Non-parametric Statistical Techniques

Menn- Kendal Analysis: Rainfall (mm)

The Mann-Kendall test, also referred to as Kendall's statistic, is a non-parametric experiment that is mainly used to repress randomness in trends in climatology and hydrology (Odedra and Jadeja 2023).

The Mann-Kendall statistics ‘S’ is given as:

S = $\sum_{i=1}^{n-1} \sum_{j=i+1}^{n} Sgn\ (xj - xi)$

When statistic ‘S’ is positive, the data is drifting upward, and when it is negative, the data is trending lower. The variance of the Mann-Kendall statistics for sample sizes n ≥ 8 is given by

Var (S) = $\frac{[n(n-1)(2n+5) - \Sigma_t (t-1)(2t+5)]}{18}$

Where ‘t’ is referred to as the extent of any tie.

Sen’s Slope

A straightforward non-parametric method created by Sen in 1968 can be used to examine the true slope of a time series if it has a linear trend.

In the sample of N data pairs, the trend line's slope is to be calculated by

$$Q = \frac{xj - xi}{j - i}$$

Where x_j and x_i are the data values at times j and i (j > i) respectively.

The median of these ‘N’ values of Q is Sen’s estimator of slope which is calculated as

$\boldsymbol{\beta} = Q\ \frac{N+1}{2}$; if N is odd.

$\boldsymbol{\beta} = \frac{Q\left(\frac{N}{2}\right)+Q\left(\frac{N+2}{2}\right)}{2}$; if N is Even.

Ultimately, β is calculated using a two-sided experiment with a 100 (1-α) % confidence interval, and the non-parametric test can then be used to find out the true slope. A rising or rising trend in a specific time series is shown by a positive value of β, and a falling or decreasing trend is shown by a negative value of β.

Auto-correlation Tests

It is mandatory to find out autocorrelation in the time series of the data before performing a trend test on rainfall data. A rough calculation of the population autocorrelation coefficient is the sample autocorrelation coefficient (Saikh et al. 2023). Both the successive coefficient and the lag-1 autocorrelation coefficient can be calculated (Piyoosh and Ghosh 2016). However, a worldly most used indicator of time series dependency is the first serial correlation coefficient to ascertain the existence of serial independence (Basistha et al. 2009; Mondal et al. 2015). An analysis is supervised by contrasting the possible hypothesis with the null hypothesis. The alternative hypothesis is accepted if there is a notable rejection of the null hypothesis. To investigate this, a significance threshold of 5% is considered suitable.

Result and Discussion

Rainfall Analysis

Descriptive Analysis of Rainfall Data

The rainfall data under analysis comprises 96 observations, all of which are complete with no missing values. The descriptive statistics, as shown in Table 1, indicate that the minimum recorded annual rainfall was 1752 mm, while the maximum reached 4338 mm. The mean annual rainfall was calculated at 2760.52 mm, with a standard deviation of 551.27 mm, indicating variability in rainfall patterns across the years. The relatively high standard deviation suggests that there is considerable fluctuation in annual rainfall, which is critical for understanding climate dynamics and water resource management in the region.

Table 1
Descriptive Statistics of Rainfall Data

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Standard Deviation
Rainfall (mm)	96	0	96	1752.000	4338.000	2760.521	551.269

Decadal Variation in Rainfall

In Fig. 3(a), which shows data from 1951 to 1960, the greatest recorded rainfall was between 2025 mm and 2285 mm, while the lowest amounts were between 3060 mm and 3317 mm. During this time, Bangladesh's average annual rainfall was roughly 2200 mm. Rainfall patterns from 1951 to 1960 are depicted in Fig. 3(b), with most values similar to the national average, though certain areas experienced above-normal rainfall. Figure 3(c) illustrates rainfall data from 1961 to 1970, revealing lower-than-average rainfall with values ranging from 1988 mm to 2380 mm. In contrast, the 1980s, as seen in Fig. 3(d), had near-average rainfall, with peak values ranging from 1952 mm to 2208 mm. Figure 3(e) displays the decade of 1981–1990, when maximum rainfall ranged from 2135 mm to 2418 mm, closely reflecting regional temperature fluctuations. The rainfall from 1991 to 2000, as shown in Fig. 3(f), was comparable with the national average. The highest recorded rainfall from 2001 to 2010, as indicated in Fig. 3(g), was between 1829 and 2103 mm. Finally, Fig. 3(h) shows the period from 2011 to 2020 when the minimum recorded rainfall was between 3360 mm and 3630 mm, which was higher than the national average. Rainfall trends from 1951 to 2010 show oscillations, with values near the national average from 1951 to 1960, below-average rainfall between 1988 mm and 2380 mm in 1961–1970, near-average levels peaking at 2208 mm in the 1980s, and rainfall ranging from 1829 mm to 2418 mm between 1981 and 2010 (Tanvir 2019).

Mann-Kendall Trend Test

Mann-Kendall trend test / 2-tailed test (mm) ;

Where,

Kendall’s tau = 0.156

S = 713

Var(S) = 99812.333

P -value (two-tailed) = 0.024

Alpha (α) = 0.05

An approximation has been used to compute the p-value.

Test Interpretation

Hypothesis

H0: No trend exists in the series.

Ha: A trend exists in the series.

The p-value (0.024) is below the significance level (α = 0.05), so we reject H0 and accept Ha. The study involved continuity correction and tie corrections. The Mann-Kendall trend test found a substantial rising trend in yearly rainfall (Kendall's tau = 0.156). This finding suggests a good trend in rainfall during the research period(Mondal et al. 2012) found a similar positive trend in northeastern Bangladesh with a Kendall's tau of 0.18, while Rahman et al. (2017) found a somewhat weaker trend (Kendall's tau = 0.12) in their study. Our findings suggest a slightly stronger trend, which may represent changing climatic circumstances caused by global climate change. This supports earlier research and has importantimplications for water resource management, agriculture, and flood risk. The coherence with current research emphasizes the importance of continuous monitoring to understand and address the effects of climate variability. More research is needed to understand the causes of these changes and their long-term repercussions.

Sen’s Slope Estimation

The Sen's Slope analysis as presented in Table 2, indicates a positive trend in annual rainfall with an average increase of 1.9 mm per year over the study period from 1950 to 2020. This analysis which considers variability across different decades, suggests a significant shift in rainfall patterns in the region.

Table 2
Confidence interval for Sen's Slope estimation of Rainfall Trends

	Value	Lower Bound (95%)	Upper Bound (95%)
Slope	1.900	0.920	11.433
Intercept	-1021.000	-10512.167	-60.600

Sen's slope analysis of annual rainfall from 1950 to 2020 indicates an average increase of 1.9 mm/year. Sensitivity analysis, depicted in Fig. 4, involves creating a rainfall model and systematically varying input parameters, such as meteorological conditions and land use, to assess their impact on rainfall outputs. This approach, using methods like factorial design or variance-based techniques, helps evaluate model robustness, precision in forecasting, and the uncertainty of rainfall projections. The observed Sen's slope of 1.9 mm/year in this study contrasts with a lower 1.2 mm/year found in other studies across Bangladesh (Ahmed et al. 2019) and is closer to a 2.1 mm/year increase reported in northern Bangladesh (Hossain et al. 2020), highlighting regional variations in rainfall trends.

Table 3 Data Table for Autocorrelation and partial correlation for rainfall trends from 1950 to 2020.

Lags	Autocorrelation	Standard error	Lower bound	Upper bound	Partial autocorrelation	Standard error	Lower bound	Upper bound
0	1.000	0.000			1.000	0.000		
1	0.551	0.106	-0.208	0.208	0.551	0.106	-0.208	0.208
2	0.349	0.134	-0.263	0.263	0.065	0.106	-0.208	0.208
3	0.021	0.144	-0.283	0.283	-0.281	0.106	-0.208	0.208
4	-0.061	0.144	-0.283	0.283	0.015	0.106	-0.208	0.208
5	-0.264	0.145	-0.283	0.283	-0.224	0.106	-0.208	0.208
6	-0.219	0.150	-0.294	0.294	0.022	0.106	-0.208	0.208
7	-0.296	0.153	-0.301	0.301	-0.143	0.106	-0.208	0.208
8	-0.124	0.160	-0.313	0.313	0.098	0.106	-0.208	0.208
9	-0.066	0.161	-0.315	0.315	0.022	0.106	-0.208	0.208
10	0.238	0.161	-0.316	0.316	0.281	0.106	-0.208	0.208
11	0.206	0.165	-0.323	0.323	-0.090	0.106	-0.208	0.208
12	0.366	0.168	-0.329	0.329	0.195	0.106	-0.208	0.208
13	0.048	0.177	-0.346	0.346	-0.398	0.106	-0.208	0.208
14	-0.058	0.177	-0.346	0.346	-0.076	0.106	-0.208	0.208
15	-0.268	0.177	-0.347	0.347	-0.070	0.106	-0.208	0.208
16	-0.267	0.181	-0.356	0.356	-0.079	0.106	-0.208	0.208
17	-0.368	0.186	-0.364	0.364	0.000	0.106	-0.208	0.208
18	-0.256	0.194	-0.380	0.380	-0.051	0.106	-0.208	0.208
19	-0.247	0.198	-0.387	0.387	0.016	0.106	-0.208	0.208

Figure 5(a): The autocorrelogram shows the temporal correlation of rainfall data for Mymensingh Division from 1950 to 2020. The x-axis represents time lags in years, and the y-axis displays the correlation coefficient, indicating the strength and direction of relationships between observations at different lags. Strong positive correlations at certain lags suggest persistent patterns, hinting at seasonal cycles or long-term trends, while weak correlations indicate randomness (Ahmed et al. 2019). Figure 5(b): The partial autocorrelogram controls for intermediate observations to highlight the direct effects of historical rainfall measurements on current values. This method isolates significant temporal dependencies, offering clearer insights into the key lags influencing rainfall patterns in the region.

Temperature Analysis

Decadal Analysis of Temperature Data

The analysis of annual temperature data for Mymensingh Division from 1950 to 2020, given in Fig. 6, demonstrates significant decade-wise variability. From 1950 to 1960, maximum temperatures were between 24.77°C and 25.06°C, while minimum temperatures ranged between 23.55°C and 23.85°C, which was lower than the area average of 27.05°C. In Fig. 6(b), greater temperatures were reported from 1961 to 1970, with maximum values ranging from 25.77°C to 26.08°C. The 1970s, represented in Fig. 6(c), exhibited a consistent range of 25.52°C to 25.62°C. Figure 6(d) depicts a little cooling in the 1980s, with maximum temperatures ranging from 24.99°C to 25.26°C and minimums ranging from 23.85°C to 24.13°C. Temperatures ranged between 24.81°C and 25.11°C from 1991 to 2000, according to Fig. 6(e). Temperatures throughout the 2000s, as indicated in Fig. 6(f), ranged between 24.77°C and 25.08°C. Figure 6(g) shows that temperatures increased between 2011 and 2020, ranging from 24.89°C to 25.17°C, mirroring recent warming trends.

Table 4
Summary of Rainfall Trends in Mymensingh Division (1950–2020)

Year	Min Rainfall (mm)	Max Rainfall (mm)	Mean Rainfall (mm)	Std Deviation
1950	1766	3317	2542.00	441.79
1960	2018	3382	2700.25	388.24
1970	1988	4338	2772.67	484.71
1980	1752	3121	2216.83	497.42
1990	2135	3837	2703.67	468.60
2000	1908	3655	2491.67	461.36
2010	1829	3475	2377.17	497.42
2020	2009	3630	2279.67	468.60

Table 4 depicts annual rainfall variations in Mymensingh Division from 1950 to 2020, with significant oscillations in minimum (1752 mm in the 1980s) and maximum (4338 mm in the 1970s) rainfall, as well as changes in standard deviation. These changes reflect times of extreme wetness and dryness, which is consistent with previous research on Bangladesh's rainfall trends. The standard deviation demonstrates variability, with some decades having more constant rainfall than others. Figure 7 shows the mean temperatures for the same time period, which ranged from 23.55°C to 26.65°C. Temperatures remained steady throughout the 1950s and 1960s, but a gradual warming began in the late 1960s. After a minor decline in the 1980s, temperatures surged again, peaking between 2010 and 2020.

Table 5
Temperature Patterns and Statistical Summary for Mymensingh

Year	Minimum Temperature	Maximum Temperature	Mean Temperature	Standard Deviation
1950	23.5519	25.3581	24.7017	0.3806
1960	24.1529	26.0833	25.6494	0.2971
1970	25.0523	25.7333	25.49	0.1301
1980	22.42	25.22	25.93	0.6092
1990	23.85	25.54	24.94	0.3623
2000	23.5689	25.4161	24.7404	0.3852
2010	24.7679	26.6502	25.9947	0.3964
2020	23.7174	25.4591	24.8371	0.3727

The regional temperature statistics for Mymensingh Division from 1950 to 2020, displayed in Table 5, reveal significant changes in mean, minimum, and maximum temperatures, with varied standard deviations. These changes represent the region's changing climate during the last seventy years. The data show significant fluctuations in temperature extremes, which are likely impacted by broader climatic variables. From 1950 to 1960, the mean temperature rose while both minimum and maximum temperatures increased. This rising trend continued throughout the 1970s, but the standard deviation fell, indicating less fluctuation in temperature extremes. The 1980s experienced a decrease in both minimum and maximum temperatures, while the mean temperature remained consistent, albeit with more variability as indicated by a larger standard deviation. Temperatures fluctuated during the 1990s, with a minor rise in mean temperature and considerable fluctuations in minimum and maximum temperatures. Temperatures fell slightly throughout the 2000s, but the latter half of the decade and the 2010s saw a dramatic increase in both minimum and maximum temperatures, in accordance with worldwide warming trends. The observed increase in mean temperature, combined with rising yearly rainfall, supports a more variable climate, echoing previous studies linking temperature increases to rainfall variability. This study's temperature rise of 0.02°C/year exceeds Bangladesh's recorded increase of 0.015°C/year. These developments are consistent with broader patterns in South Asia, where global warming is causing increased temperature and rainfall variability.

Temperature Trends and Rainfall Variability Effects

The climatic conditions observed in the Mymensingh Division from the year 1950 to 2022 exhibited considerable fluctuations in both precipitation and temperature. In the decade of the 1950s, the annual rainfall experienced a substantial increase from 1766 mm to 3317 mm by the 1960s, ultimately reaching a peak of 3655 mm in the 2000s before stabilizing at 3630 mm in the 2020s. Rainfall levels remained relatively stable throughout the decades of the 1970s and 1980s, characterized by only minor fluctuations. The temperature, which experienced a slight increase during the 1950s and 1960s, witnessed a significant escalation in the 1980s, attaining its zenith in the late 1980s. This upward trajectory in temperature persisted throughout the 1990s and 2000s, coinciding with an increase in precipitation levels. In the most recent decades, the trends pertaining to both temperature and rainfall have continued to ascend, indicating a potential correlation. Decadal and autocorrelation analyses have unveiled noteworthy alterations in climatic patterns, underscoring the variability of precipitation (Shahid 2010) and the periodic fluctuations in temperature (Hossain et al. 2018). These findings are consistent with prior research on climate variability.

Extreme Climatic Events Occurred in Mymensingh Division from 1950 to 2020

The exploration of severe weather phenomena in Mymensingh Division (1950–2020) uncovers intriguing links between escalating temperatures and the surge in rainfall. Particularly, the late 1980s marked a period where temperature and precipitation soared in tandem, suggesting intricate climate dynamics (Karmakar and Shrestha 2000). During the decade spanning the 1950s to the 1960s, annual rainfall dramatically escalated from 1766 mm to an impressive 3317 mm, with temperatures also climbing steadily. By the twilight of the 2000s, annual rainfall soared to 3655 mm, a trend that persisted into the 2010s and 2020s (Shahid 2010). The 1970s and 1980s exhibited consistent rainfall, yet temperatures reached their zenith in the late 1980s.These observed trends resonate with the broader narrative of global climate change, underscoring the heightened occurrence of extreme weather phenomena in Bangladesh. Mymensingh's susceptibility to these climatic alterations accentuates the urgent requirement for effective water management and resilient infrastructure.

Conclusions

Rainfall and temperature statistics for Mymensingh Division from 1950 to 2020 show major climatic shifts with far-reaching ramifications for water supplies, agriculture, and ecosystems. The results show a significant increase in both temperatures and annual rainfall. The Mann-Kendall trend test finds a Kendall's tau of 0.156 with a p-value of 0.024, while Sen's Slope analysis shows a 1.9 mm annual rise in rainfall (Ahmad et al., 2023; Akter et al., 2023). This rainfall variability, which encompasses both extreme wet and dry spells, highlights the region's increased sensitivity to changing climate patterns. This observation is consistent with global trends (Harris et al., 2020; Alam et al., 2023). The higher trend in temperatures found in this study is consistent with global warming predictions, highlighting the crucial need for effective ways to reduce and adapt to these climatic changes (Rahman & Lateh, 2017; Karmakar & Shrestha, 2000; Shahid, 2010). The increase in temperature and rainfall creates a complicated combination of difficulties for water supply reliability, agricultural production, and ecosystem health. Addressing these difficulties necessitates a comprehensive strategy that includes both mitigation and adaptation measures. A thorough understanding of regional climate dynamics is critical for formulating evidence-based policy and effective response strategies. Continued study and observation are required to improve our understanding of how climate change affects local ecosystems and human systems. This study gives unique insights into the climatic shifts affecting Mymensingh Division, emphasizing the need of incorporating these findings into policy and planning. Using this knowledge, stakeholders can develop tailored interventions to address specific risks, encourage sustainable behaviors, and boost resilience across many sectors. Furthermore, preventive interventions based on reliable data might help predict future issues and mitigate potential dangers linked with ongoing climate variability. The integration of scientific discoveries into practical solutions will be critical for navigating the changing climate scenario and ensuring the region's long-term sustainability.

Declarations

Ethics Approval and Consent to Participate

This is not relevant to the current study

Consent for Publication

This is not relevant to the current study.

Availability of Data and Material

The datasets employed in this investigation are sourced from publicly accessible repositories, namely the CRU TS (Climatic Research Unit gridded Time Series) dataset. The CRU TS dataset is readily available through the Climatic Research Unit's archive at the University of East Anglia and can be retrieved at https://crudata.uea.ac.uk/cru/data/hrg/. Supplementary processed data and materials utilized throughout the present study can be obtained from the corresponding author upon reasonable inquiry.

Competing Interests

The authors have disclosed that there are no potential conflicts of interest.

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Authors' Contributions

The manuscript was carefully crafted through the collaborative efforts of all listed authors. KH Haque took on the main responsibility for writing the initial draft and conducting the data analysis, ensuring that the research findings were presented with both rigor and accuracy. RK Hassan, who serves as an Assistant Professor in the department, made significant contributions to the review and editorial processes, thus ensuring that the manuscript met high academic standards. All authors worked closely together throughout the research project and have approved the final version of the manuscript.

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Contributions of Authors

The manuscript was developed through the collaborative efforts of all listed authors. KH Haque was responsible for writing the original draft and conducting the data analysis, ensuring that the research findings were thoroughly and accurately presented. RK Hassan, who is an Assistant Professor in the department, contributed significantly to the review and editing process, ensuring the manuscript met high academic standards. All authors worked closely together throughout the research process and have approved the final version of the manuscript.

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Figures

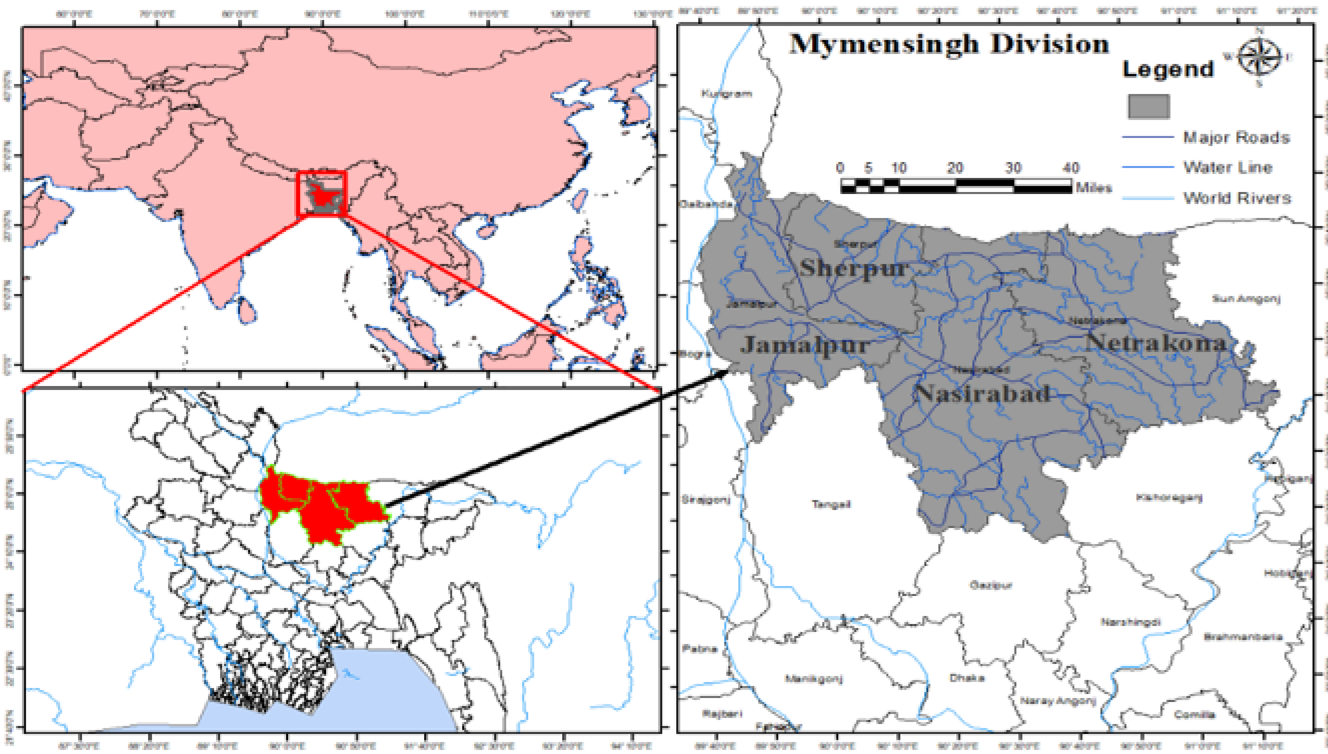

Figure 1

Study area overview of Mymensingh Division

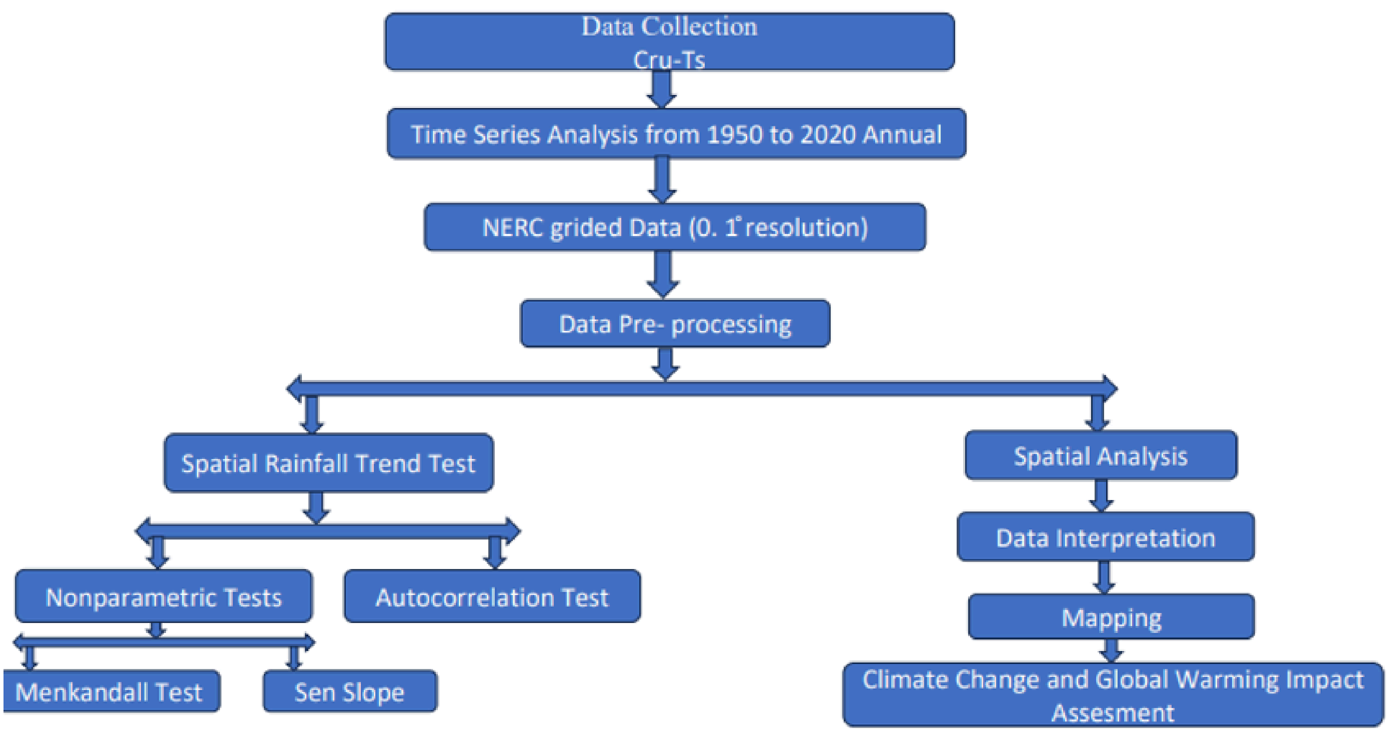

Figure 2

Workflow diagram for data processing methodology

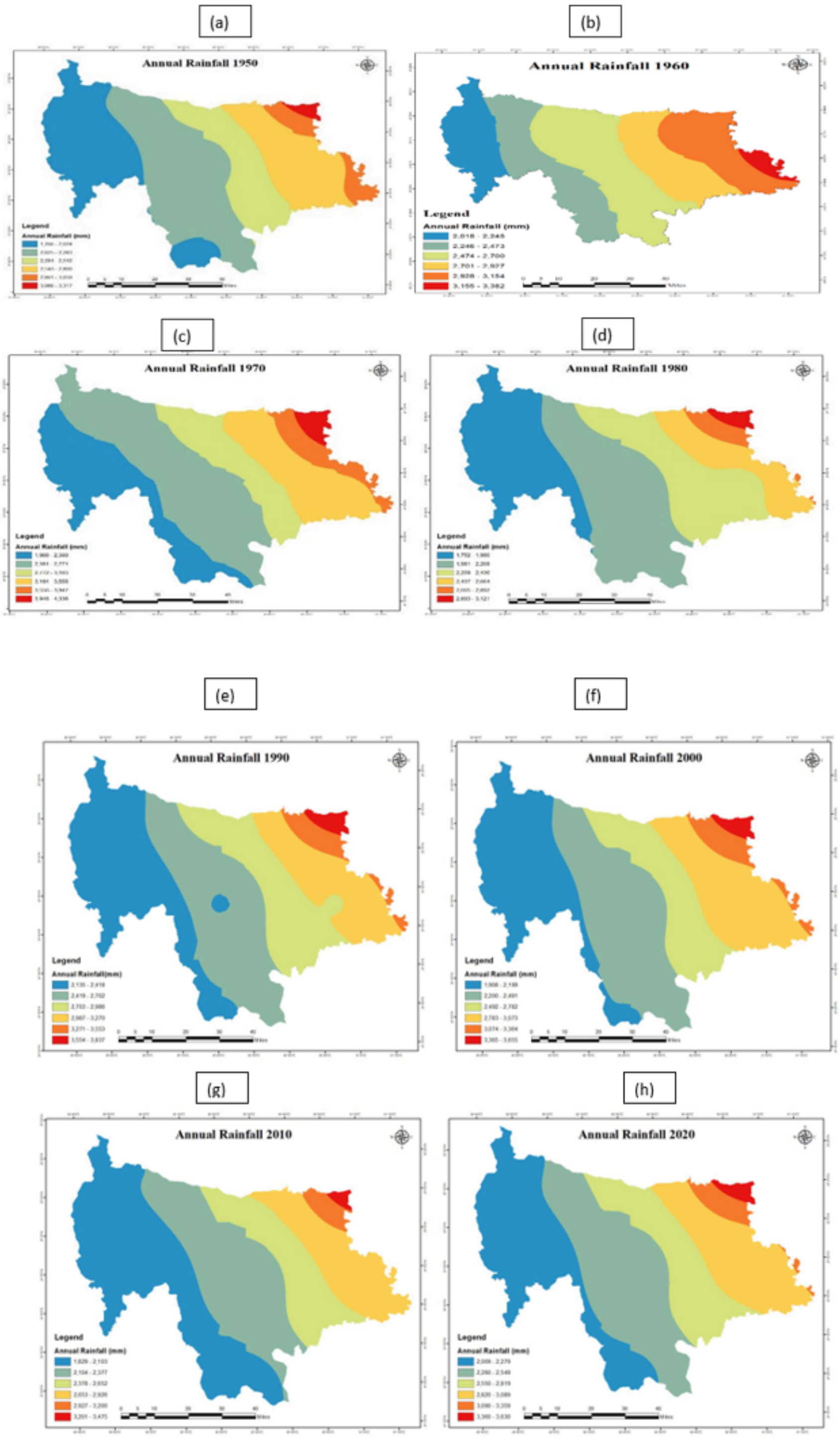

Figure 3

a, b, c, d, e, f, g, h Decadal Variation in Annual Rainfall in Mymensingh division (1950-2020)

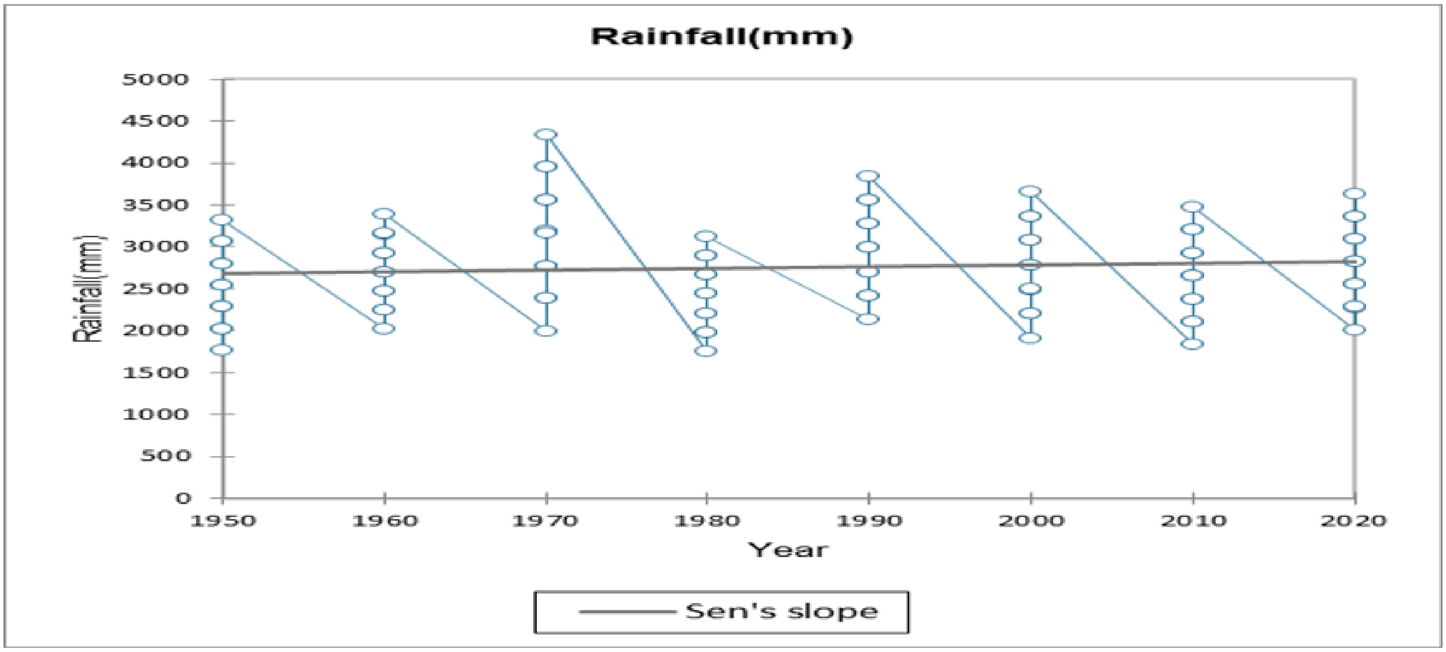

Figure 4

Sen's Slope analysis of long-term trends in Mymensingh

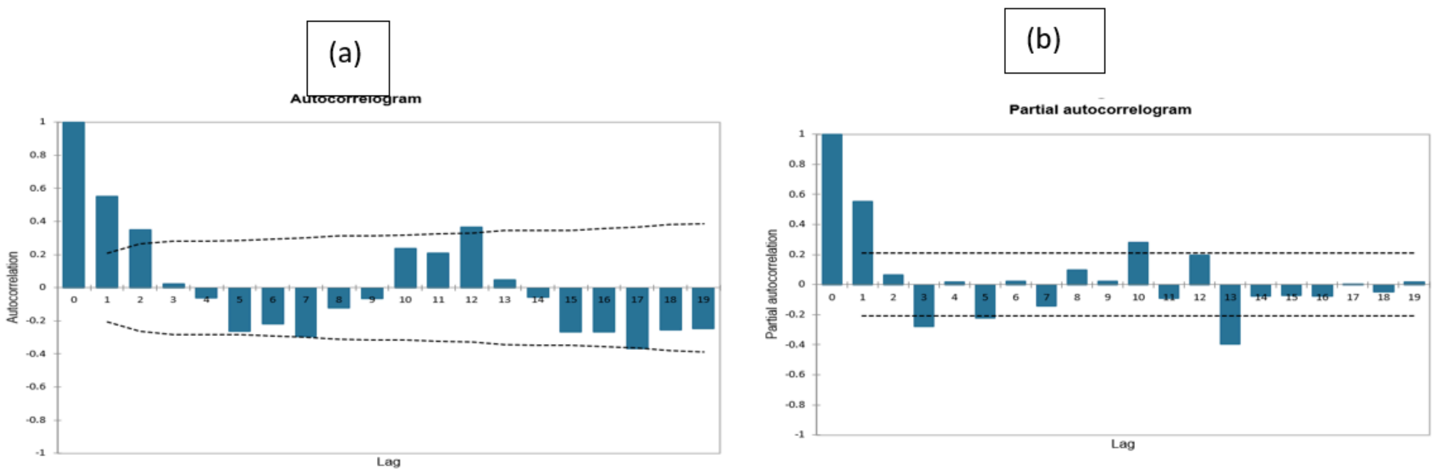

Figure 5

a, b Autocorrelation and Partial Autocorrelation of rainfall data.

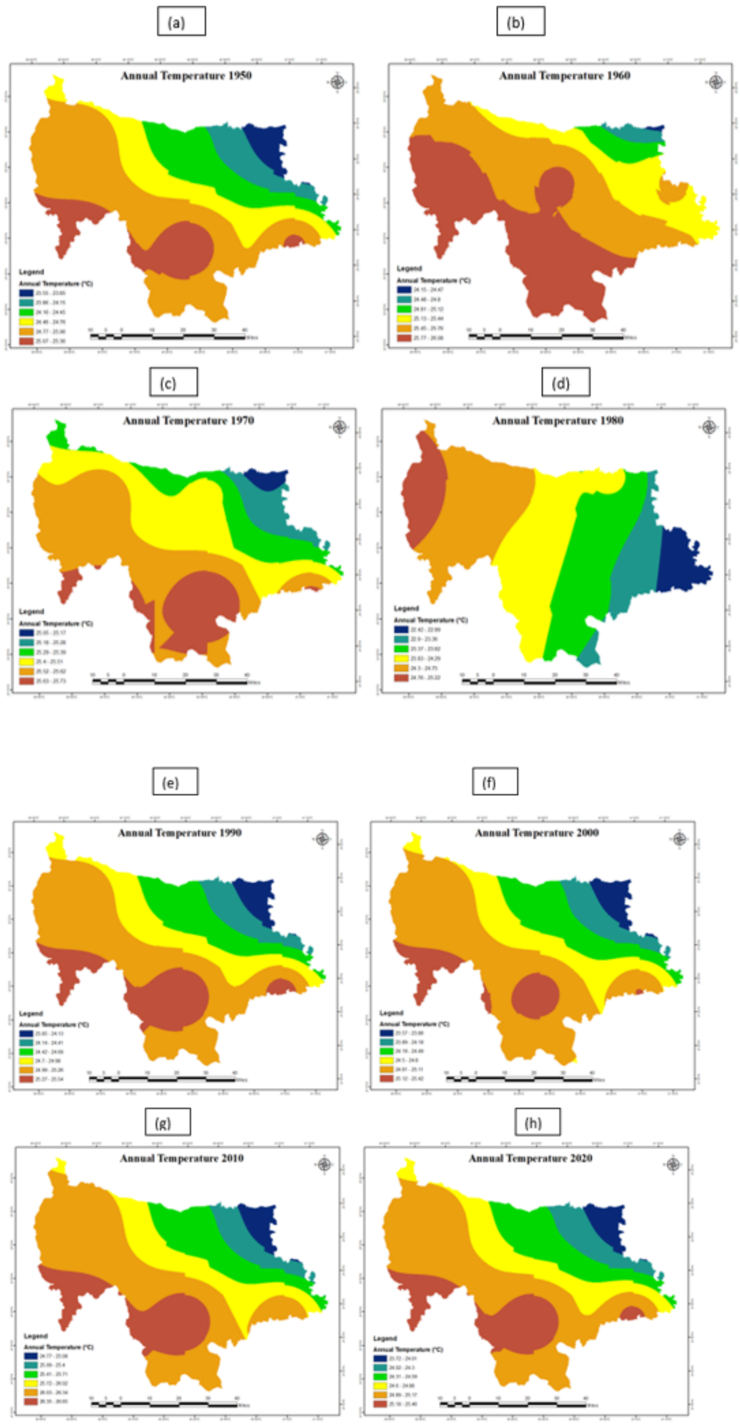

Figure 6

a, b, c, d, e, f, g, h Annual temperature data covering per decade from 1950 to 2020.

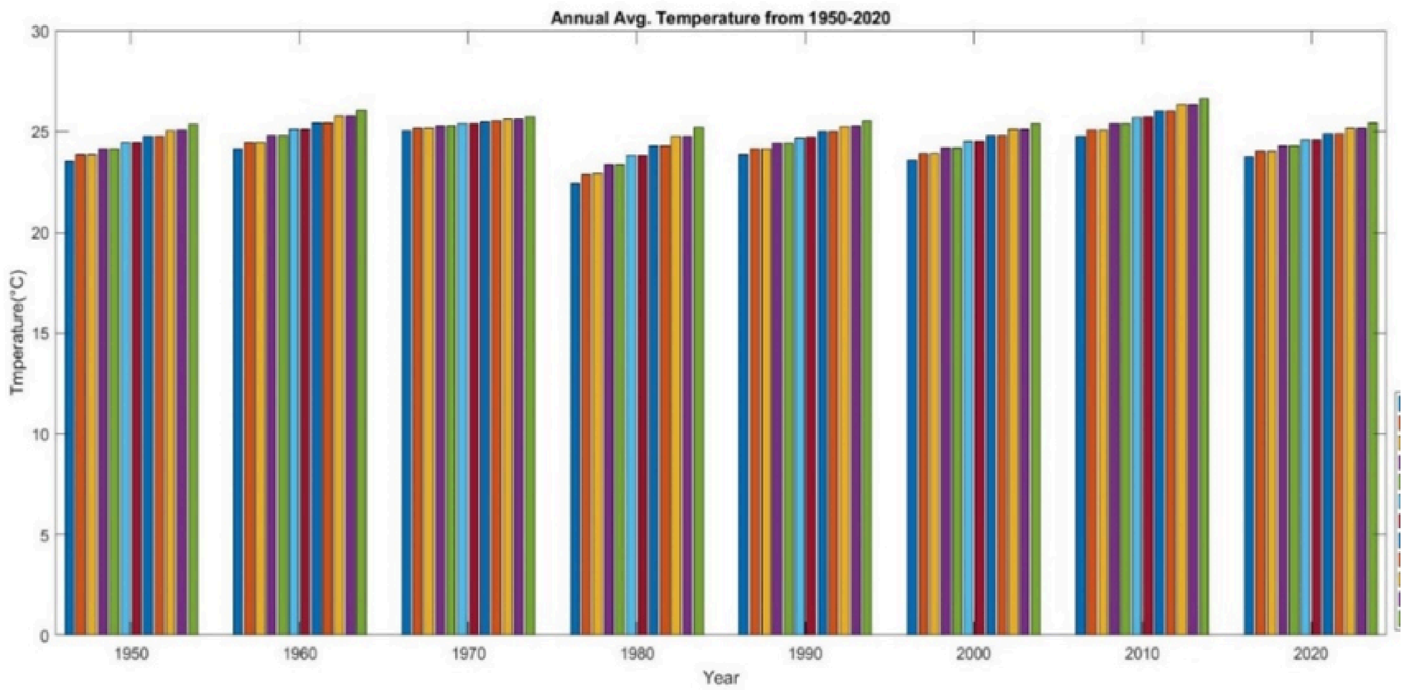

Figure 7

Annual Avg. temperature (˚ C) from 1950 to 2020.

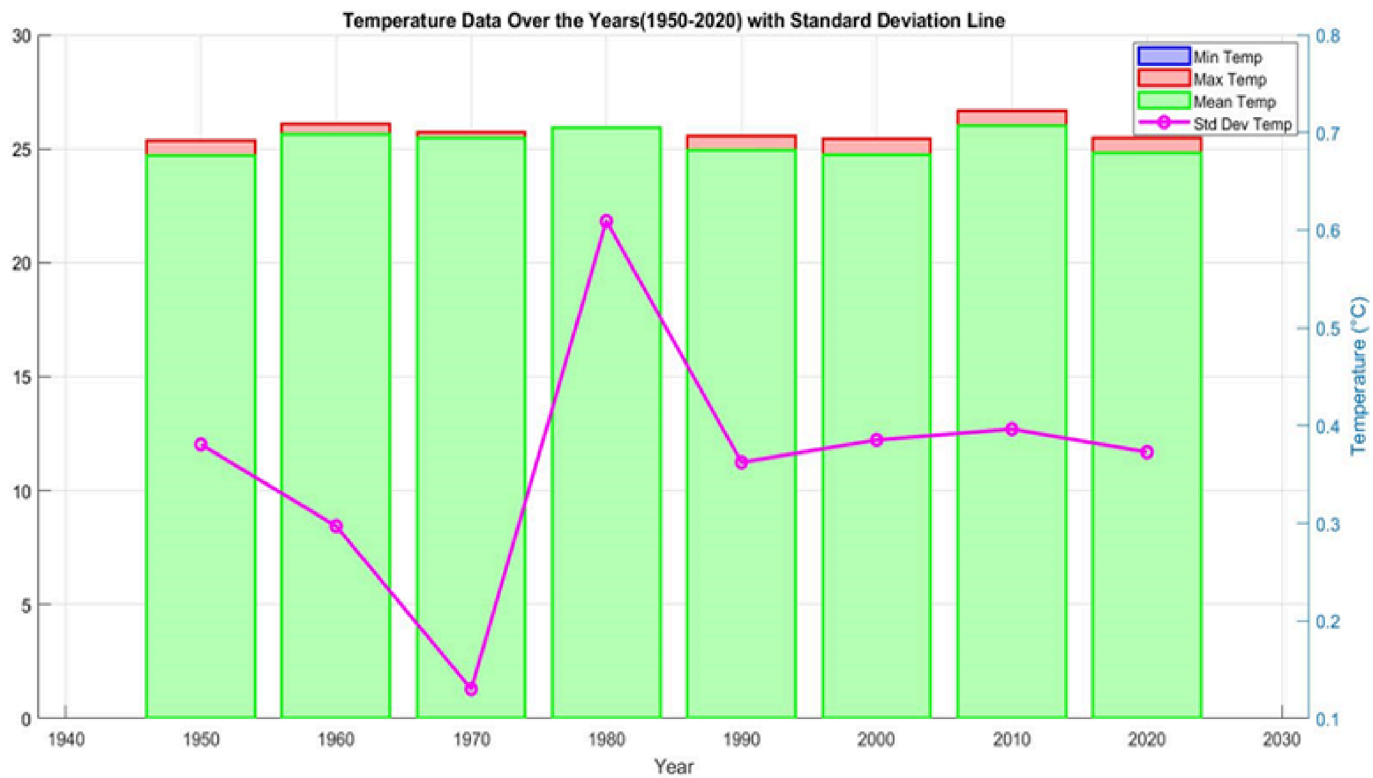

Figure 8

Statical analysis for temperature from 1950 to 2020.