RECENT TREND ANALYSIS OF METEOROLOGICAL PARAMETERS OVER MYMENSHING REGION USING STATISTICAL AND NUMERICAL TECHNIQUES

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Abstract

The ancient Brahmaputra River, which flows along its northern border, is what sets the larger Mymensingh region apart. Mymensingh's climate, which is closer to Meghalaya, is humid subtropical with monsoon influences. It is slightly colder than Dhaka's. The dry season is pleasant and largely clear, whereas the wet season is oppressive, hot, and overcast. The four meteorological variables in our trend analysis are temperature, relative humidity, dew temperature, and rainfall. The monotonic trend and amplitude of each trend are estimated using the Mann-Kendall (MK) non-parametric test and Sen's slope test, respectively. The rainfall series data set's statistical analysis reveals that rainfall is erratic and informal, and that both the seasonal and yearly rainfall trend seem to be rising.

In this study of twenty-five years timespan, the region of Mymensingh experienced some salient weather phenomenas including an unusual yearly temperature decrease of 0.0053°C due to the drough intensity whereas the temperature in Monsoon and Post-Monsoon increased by 0.056°C and 0.0163°C respectively, increase in Relative humidity by 0.21% per year and an incrase of 14.184 mm of annual total rainfall. The parameters did not show any significant trend in Post-Monsoon season over the years, mostly.

Keywords : Trend Analysis, Monotonic Trend, Mann-Kendall, Sen's Slope, Rainfall series data, Statistical Analysis, Drough intensity.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Globally, the scientific community has paid close attention to how climate change affects air temperature and rainfall. Numerous investigations have been conducted to demonstrate that these variations in rainfall and temperature are becoming noticeable on a worldwide basis. Global climate change has occurred, yet its effects frequently differ from place to place. Therefore, assessing the shift in meteorological variables is a crucial step in the identification of climate change. Numerous studies have demonstrated the severe effects that climate change has on natural ecosystems, society, and the economy. These effects can result in a shortage of water resources as well as an excess of floods and droughts. There are clear indications that rainfall patterns are changing both locally and worldwide as a result of global warming.

Bangladesh's climate is defined by high temperatures, frequent heavy rains, high humidity, and noticeable seasonal fluctuations. The country is situated in the tropical monsoon area. Researchers and decision-makers have paid close attention to studies on climate change conducted around the nation in recent years. Climate models are used in a significant number of national research on global climate change to assess future estimates and uncertainties. In the context of the Intergovernmental Panel on Climate Change (IPCC) diagnostic exercise for the Fifth Assessment Report (AR5), the maximum temperature, precipitation, and their potential future changes are assessed in an ensemble of the 5th Phase Coupled Model Inter-comparison Project (CMIP5). Additionally, the available historical data collected by the Bangladesh Meteorological Department (BMD) during the period 1981-2008 in the northwest region of Bangladesh is also compared. The average maximum temperature has been found to be increasing at a positive trend for both BMD data and MPI-ESM-LR (CMIP5) model data, with rates of growth of 0.29°C and 5.3°C centennially, respectively. However, according to BMD data and MPI-ESM-LR (CMIP5) model data, the rate of decrease in rainfall is 8.8 mm and 40.1 mm per century, respectively. It can be observed that January had the least amount of rainfall during the monsoon, and July had the most. In comparison to the previous year, the peak frequency is marginally less than 12 months, indicating that the key events take place prior to the year's conclusion. The MPI-ESM-LR (CMIP5) model data indicates that between 2040 and 2100, the usual temperature in the northwest will rise at a rate of 1.62°C.[3]

Rainfall is the primary physical strait that conducts water from the atmosphere back to earth's surface and links climate, weather and hydrological cycles. The rainfall dominated climate of Bangladesh receives the heaviest rainfall amongst the other regions of the world. There was no momentous trend in Bangladesh's annual, seasonal, or monthly rainfall. The summer monsoon is the main rainy season in Bangladesh which accounts for about 72% of the annual rainfall.(Ahasan *et al*, 2008) [2]
Like rainfall, many meteorological parameters like temperature, dew temperature, and Relative Humidity are crucial in describing the climate of Bangladesh. Changes in rainfall and temperature have already had an impact on food production in several regions of the nation, and there is now much less arable land. The coastal land that has historically been used for rice production is seriously being impacted by the intrusion of salinity.

Understanding and making the reliable decisions regarding Rainfall, Temperature, and Relative

Humidity trends in climate change and calamity management is essential. This study conveyed a trend analysis for monthly, seasonal, and annual data of the aforementioned Statistical Parameters within the Mymensingh division. Mean-Kendall test and Regression analysis were used to track out the trend, and the Sen.'s Slope method to determine the magnitude of the change in climate time series.

Since the time series distribution in this study is unknown, we attempted to use the Mann-Kendall approach to identify the trends in temperature, precipitation, and minimum and maximum temperatures, as well as the size of these trends using the Sen Slope estimator method. For the analysis, three stations were considered. Prior to doing a trend analysis, earlier studies' data were treated as missing information.

1.1 Terminology

Trend Analysis: Trend analysis is a method used to analyze data over time to identify patterns, tendencies, or shifts in behavior. It involves examining historical data points collected at balanced intervals to detect any coherent upward, downward, or stable movements in the data. In meteorology, Trend analysis is fundamental in predicting posterior indeterminacy.

Mann Kendall: Mann-Kendall (also called $M - Ktest$) is used to examine if time series data show a monotonic trend (either growing or decreasing) over the course of time. M-K test is particularly useful when the data does not meet the assumptions of parametric tests, such as normality or independence. It is a non-parametric test that is frequently used to assess data patterns in the domains of hydrology, climatology, and other sciences.

Sen's Slope Estimator: The Sen's slope estimator is a non-parametric technique for calculating the slope of a time series trend line. By calculating the median of all potential pairwise slopes between data points, its simplicity and robustness offers a reliable and resilient assessment of the trend.

Regression Analysis: The link between a dependent variable and one or more independent variables is simulated using a statistical technique called regression analysis. It helps with forecasting the values of the relevant meteorological parameters and understanding the link between the independent and dependent variables.

Rainfall Pattern: The distribution and variability of rainfall over a certain area or time period is referred to as a rainfall pattern. It encompasses various aspects of rainfall, including seasonal patterns, trends over time, spatial distribution, quantity, frequency, and extreme events.

Upward Trend: An upward trend is the steady rise or improvement in a variable's values over time. It denotes a trend of development or advancement.

Downward Trend: A downward trend in the values of a variable over time is referred to as a steady decline or negative change. It denotes a pattern of deterioration or decline.

Correlation: The statistical concept of correlation measures the degree and direction of the association between two variables. It shows how closely one variable's value is related to another variable's value. The range of a correlation coefficient is -1 to $+1$, with a perfect negative correlation (Decreasing proportionality) denoted by -1, a perfect positive correlation (Increasing proportionality) by $+1$, and No association between the variables denoted by a correlation value of 0.

BMD: The national organization in charge of predicting the weather and keeping an eye on the climate in Bangladesh is the Bangladesh Meteorological Department (BMD). BMD employs sophisticated algorithms and data gathered from a nationwide network of weather stations to produce weather forecasts and warnings. They offer vital data to benefit industries like agriculture, transportation, and disaster relief. BMD aids policymakers in creating solutions to deal with climate-related problems by monitoring climate variability and change. BMD is committed to safeguarding the public's safety and well-being and promoting sustainable development in Bangladesh with a committed team of professionals.

1.2 Study Area

Our objective area in this study is the Mymensingh district, which is located 19 meters above sea level at latitude 24.7460°N and longitude 90.4179°E. Mymensingh experiences cold winters and wet summers due to its humid subtropical climate. The wettest month is May, with the city receiving an average of 2541 mm of rain annually. The typical annual The hottest months are April and May and the coolest months are December and January. Average temperature is nearly 28.75ºC. Relative humidity often exceeds 70% throughout the year. (**Mymensingh, Dhaka, Bangladesh Climate**) Trend analysis in Mymensingh, Bangladesh, can encompass various meteorological parameters to understand how they have been changing over time. [Figure:2] shows the regional map of Mymensingh which is generated using **ArcGIS**.

Figure 1: Mymensingh region.

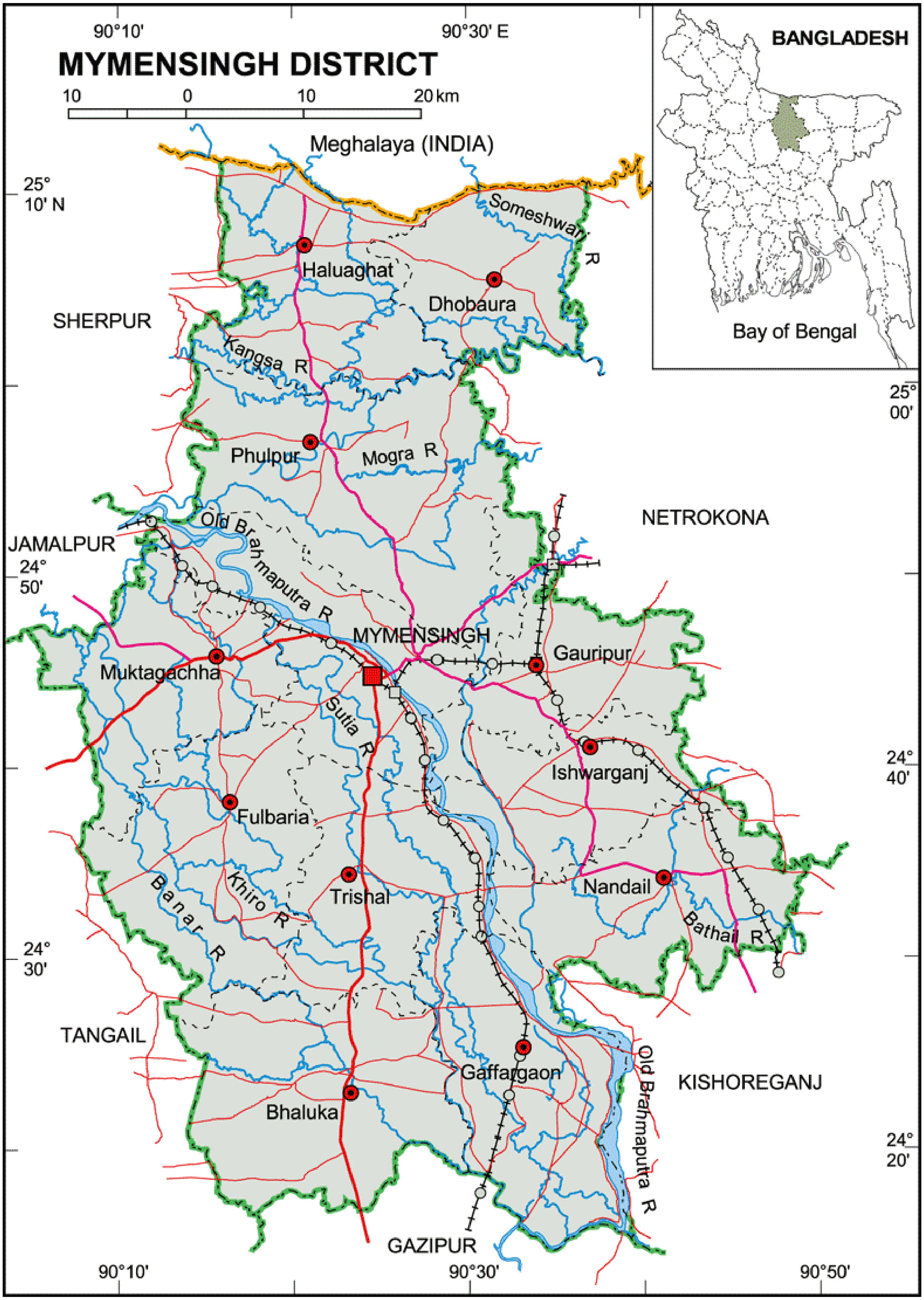

Figure 2: Study Area Mymensingh.

CHAPTER 2

MATERIAL AND METHODS

2.1 Data Source and Formulation

Data Source

We have accumulated the daily data on Maximum Temperature, Minimum Temperature, Average Temperature, Rainfall, Relative Humidity and Dew-Point Temperature of our assigned region, Mymensingh from Bangladesh Meteorological Department (BMD). Data for all parameters spans from 1998 to 2022.

Data Processing and Formatting

We have analyzed our raw data based on yearly and seasonal mean. For yearly mean, the total data is divided by the number of days and in the case of seasonal mean, the months that corresponds to the intended season, *i.e.* March-May for summer, June-September for monsoon, October-November for post-monsoon and December-February for winter season. The daily values for each metric are added and then yearly mean temperature is divided by the number of days in each season. Maximum and minimum temperatures are calculated as a representative value for that year. The collected data is processed and concluded using Python Programming and a developed MATLAB code is used to calculate all our required parametric values required for this work. Numerical Techniques and methods are used to examine and track the behavior of certain trends as well as managing the large quantity of data. The yearly time series data of each parameter is then forecasted for the next ten years (2023-2032) using a script of Python.

2.2 Methodology

Trend is determined by the relationship between the two variables of temperature, rainfall and their temporal resolution. The statistical method such as regression analysis and coefficient of determination R^2 are used for the significance of trend of temperature and rainfall.[6] Throughout the entire work, we have used Mann-Kendall Test, Sen's Test, and the Hypothesis test alongside of Linear Regression to calculate the value of R-squared.

Increasing or decreasing trends of all the independent weather parameters (*e.g.*, annual, seasonal, monthly temperature, rainfall, relative humidity, etc.) were statistically examined in two phases. The first one uses the non-parametric Mann-Kendall test, and the second one is the non-parametric Sen's slope estimator. The trend was detected based on the normalized test statistics Z and $p-value$.

One of the primary obstacles in detecting and interpreting trends is The Confounding effect of serial dependence. A confounding effect occurs when the relationship between two variables is distorted or misrepresented by the presence of a third variable. Serial correlation pattern in the data is regarded for determining the significance level of the Mann-Kendall test results.

In particular, if the time series exhibits positive serial correlation, the non-parametric test will indicate a significant trend in a time series that is, in reality, random more frequently than the significance level specifies.

Regression Analysis : Linear Regression

Linear regression is one of the most basic and popular machine learning methods. It's a statistical method for study of forecasts. Linear regression produces predictions for continuous/real or numerical variables such as age, product price, sales, and so on. Within the framework of trend analysis, linear regression aids in locating and measuring the trend or pattern that exists in the data across time, offering insights into the trend's direction, size, and importance.

Mathematical Equation: In trend analysis, X typically represents time, and Y represents the meteorological parameter being studied over time. By estimating the best-fitting line across the data points, the linear regression equation enables us to predict the dependent variable from the independent variable. The equation as follows :

$$Y = \beta_0 + \beta_1 X$$

Where:

- Y is the dependent variable (the observed values over time).
- X is the independent variable (time or the sequence of observations).
- β_0 is the intercept, representing the initial value of the dependent variable X *i.e.*, at the starting point of the analysis prediod.
- β_1 is the slope, representing the rate of change of the dependent variable with respect to the independent variable(time). It indicates the direction and magnitude of the trend.

Calculation of Coefficients of β_0 and β_1

Calculate the mean values of X and Y:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} X_i$$

$$\bar{y} = \frac{1}{n}\sum_{i=1}^{n} Y_i$$

Calculate the sum of squares:

$$S_{xx} = \sum_{i=1}^{n}(\bar{x} - X_i)^2$$

$$S_{yy} = \sum_{i=1}^{n}(\bar{y} - Y_i)^2$$

$$S_{xy} = \sum_{i=1}^{n}(X_i - \bar{x})(Y_i - \bar{y})$$

Calculate the slope(β_1) and intercept(β_0):

$$\beta_1 = \frac{S_{xy}}{S_{xx}} = \frac{\sum_{i=1}^{n}(X_i - \bar{x})(Y_i - \bar{y})}{\sum_{i=1}^{n}(\bar{x} - X_i)^2}$$

$$\beta_0 = \bar{y} - \beta_1\bar{x}$$

Key aspects of Linear Regression

1. **Linear relationship:** The relationship between the dependent variable and the independent variable(s) is assumed to be linear. This means that the change in Y is directly proportional to the change in X(s).

2. **Regression co-efficients:** The slope of the regression line, or how much the dependent variable changes for a one-unit change in the independent variable, and the intercept, or the anticipated value of the dependent variable when all independent variables are zero, are represented by the co-efficients in linear regression.

3. **Least Squares Estimation:** Linear regression aims to find the best-fitting line through the data points. It uses the method of least squares to minimize the sum of the squared differences between the prospered values and the values measured by the regression line.

4. **Assumptions:** Linear regression relies on several assumptions, including linearity (the relationship between variables is linear), independence of errors (the errors are not correlated with each other), constant variance of errors (**homoscedasticity**), and errors of normal distribution.

5. **Prediction:** Once the linear regression model is fitted, it can be used to predict the values of the dependent variable for new values of the independent variable.

6. **Interpretability:** Linear regression provides basic modifiable coefficients, making it easy to understand the relationship between the independent and dependent variables.

Coefficient of Determination(R-Squared):

The Co-efficient of Determination (R^2) is the measurement of the accuracy to which a statistical model predicts an outcome. The outcome is represented by the model's dependent variable. More precisely, R^2 is a measure of goodness of fit. The lowest possible value of $\mathbf{R^2}$ is 0 and the highest possible value is 1. Put simply, the better any model is at making predictions, the closer its $\mathbf{R^2}$ value will be to 1.

Mathematical Formulation:

$$R^2 = \frac{MSS}{TSS}$$
$$R^2 = 1 - \frac{RSS}{TSS} \qquad ; [\because TSS = MSS + RSS]$$
$$RSS = \sum_{i=1}^{n} (\hat{y}_i - \bar{y})$$
$$TSS = \sum_{i=1}^{n} (Y_i - \bar{y})$$
$$MSS = \sum_{i=1}^{n} (y_i - \bar{y})$$

$\therefore$ We can write,

$$R^2 = 1 - \frac{\sum_{i=1}^{n} (Y_i - \hat{y})^2}{\sum_{i=1}^{n} (Y_i - \bar{y})^2}$$

Where:

- Y_i: Observed value of the dependent variable (Y) for each data point.
- $\bar{y}$: Mean of the dependent variable (Y).
- $\hat{y}$: Predicted value of the dependent variable (Y) from the regression model for each data point
- n: Number of data points.
- TSS: Total Sum of Squares.
- RSS: Sum of Squares of Residuals.
- MSS: Model Sum of Squares. (also known as ESS, or Explained Sum of Squares)

Signification: The following table expounds the declarations regarding the value of R^2 :

$\mathbf{R^2}$	**Interpretation**
$R^2 < 0.25$	The model is not a good fit for the data.
$R^2 = 0.25 - 0.50$	The model is a fair fit for the data.
$R^2 = 0.75 - 0.90$	The model is a very good fit for the data.
$R^2 = 0.90 - 1.00$	The model is a perfect for the fit data.

Table 1: R^2 Value Interpretation.

Pearson Correlation Co-efficient(r)

Pearson correlation co-efficient, also known as *Pearson R statistical test*, measures the strength between the different variables and their relationships. In order to determine the strength of the association between the two variables, the analyst should always compute the correlation coefficient value whenever a statistical test is performed between the two variables.

Mathematical Equation: If we consider x_i and y_i ; $i = \overline{1,n}$ to be the variables of two different parameters, then the correlation coefficient r can be evaluated as follows:

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

Alternatively,

$$r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$$

Where:

$$S_{xx} = \sum_{i=1}^{n}(x_i - \bar{x})^2$$

$$S_{xy} = \sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})$$

$$S_{yy} = \sum_{i=1}^{n}(y_i - \bar{y})^2$$

Interpretation of r value:

Correlation Coefficient	Interpretation
±1.0	Perfect correlation (Positive/Negative)
±0.9 to ±1.0	Very high correlation (Positive/Negative)
±0.7 to ±0.9	High correlation (Positive/Negative)
±0.5 to ±0.7	Moderate correlation (Positive/Negative)
±0.3 to ±0.5	Low correlation (Positive/Negative)
±0.1 to ±0.3	Weak correlation (Positive/Negative)
±0.0 to ±0.1	Little or no correlation

Table 2: Interpretation of Pearson Correlation Coefficient Values.

Mann-Kendall Test

The Mann Kendall Trend Test *(or the M-K test)* is used to analyze data collected over time for consistently increasing or decreasing trends (monotonic) in dependent variable *i.e.*, y values. It is a non-parametric test, which means it works for all distributions. If the data do not conform to a normal distribution, the Mann-Kendall test can be applied. This test evaluates whether y values tend to increase or decrease over time through what is essentially a non-parametric form of monontonic trend regression analysis.[11]

Figure ?? shows the absence of a significant trend of annual rainfall variability in Caicó, simulated using M-K test with a p-value = 0.619. Therefore, this variability in precipitation is an inherent characteristic of different conditions.[4]

Mathematical Formulation: The Mann–Kendall test statistics S is calculated as:

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

$$sign(x_j - x_k) = \begin{cases} 1 & \text{if } (x_j - x_k) > 0 \\ 0 & \text{if } (x_j - x_k) = 0 \\ -1 & \text{if } (x_j - x_k) < 0 \end{cases}$$

The formula to calculate Variance follows,

$$Var(S) = \frac{n(n-1)(2n+5) - \sum_{t=1}^{p} t_i(t_i - 1)(2t_i + 5)}{18}$$

A tied group is a set of sample data having the same value. In case of no tied groups, this summary process (p sign) can be ignored. In the case where the sample size $n > 30$, the standard normal test statistic Z is estimated by:

$$Z = \begin{cases} \frac{S-1}{\sqrt{Var(S)}} & \text{if } S > 0 \\ 0 & \text{if } S = 0 \\ \frac{S+1}{\sqrt{Var(S)}} & \text{if } S < 0 \end{cases}$$

Where:

- S is the Mann-Kendall statistic.
- n is the number of data points in the time series.
- x_j and x_k are the data values at time j and k, respectively.
- p is the number of Tied groups.
- t_i is the number of data values in the pth group.[10]

Signification: A Positive $Z - value$ indicates an Increasing trend whereas a Negative $Z - value$ indicates a Decreasing trend. There are no significant trend between the variable parameters if the $Z - value$ is close to zero and no trend present for $Z = 0$.

Advantages of Mann-Kendall test

1. **Independent of Distribution:** The Mann-Kendall test does not take any specific distribution of the raw data, making it compatible for non-normally distributed data or data with outliers. This property makes this method robust against assumptions that may not be exact in real-world datasets.

2. **Sensitivity to monotonic trends:** The Mann-Kendall test is sensitive to monotonic trends, including increasing, decreasing, or no trend patterns in the data. It does not require the trend to follow a specific mathematical form, which allows a flexibility in analysis of the trend.

3. **Applicability to small sample sizes:** The Mann-Kendall test performs well even with trivial sample sizes, which is advantageous when dealing with limited data availability, especially in the challenging data collection fields like geology and environment.

4. **Handling tied observations:** The Mann-Kendall test can handle tied observations, where multiple data points have identical value. This is particularly useful when dealing with time series data, where similar observations are quite common.

5. **Statistical power:** The Mann-Kendall test has good statistical power, meaning it is effective at detecting significant trends in the data when they exist. This makes it a reliable method for trend analysis in various fields, including environmental science, hydrology, climatology, and epidemiology.[7]

6. **Ease of interpretation:** The results of the Mann-Kendall test are relatively easy to interpret. The presence or absence of a significant trend can be deduced directly from the test statistic and associated *p-value*, facilitating straightforward communication of results to decision-makers.

Sen's Slope Test

When estimating the slope of a linear trend, linear regression is used to compute the least squares estimate. However, the approach is highly sensitive to outliers and is only valid in the absence of serial correlation. Sen's Slope test or estimator is a method used to estimate the slope of a linear relationship between two variables when there are outlier values or errors in the dataset. Sen's slope is considered better to detect the linear relationship as it is not affected by outliers in the data *(Ray et al. 2021)*[8].
In this work, Sen's slope is applied following M-K test to calculate the magnitude of the trend for temperature and rainfall data.[5]

Mathematical Formulation: The equation below is used to estimate each individual slope (Q_i):

$$Q_i = \frac{Y_j - Y_k}{j - 1}$$

Where:

- Y_j and Y_k are the data values at time j and k, respectively.
- $i = \overline{1, n-1}$ and $j = \overline{2, n}$.

If in the time series, there are n values of Y_j, estimates of the slope will be $N = \frac{n(n-1)}{2}$. The slope of the Sen estimator is the mean slope of such slopes' N values. The Sen's slope is:

$$Q_{ij} = \begin{cases} Q_i = \frac{Y_j - Y_k}{j-1} & \text{if } n \textit{ is Odd} \\ \\ \frac{1}{2}\left(Q_{\frac{N}{2}} + Q_{\left[\frac{N+2}{2}\right]}\right) & \text{if } n \textit{ is Even} \end{cases}$$

Signification: The positive Q_i indicates an increasing trend, while the negative Q_i values tell us that there is a negative trend in the existing data.

Properties of Sen's Slope estimation

- Sen's Slope test is considered to be better at detecting the linear relationship because it has the advantage over the slope of regression, in the sense that gross data series errors and outliers do not affect in much.[9] It also considers missing data.
- Data should be sorted in ascending order according to time.
- Sen's slope and the Mann-Kendall test are frequently combined to determine the importance of a trend in a time series. M-K test can be used to detect whether a time series of data contains a statistically significant trend. Sen's slope can be used to calculate the M-K test's significance level by hypothesis test and determine the trend's rate of change.

Hypothesis Test

A type of statistical inference known as Hypothesis testing makes inferences about a population parameter or population probability based on data from a sample.

Initially, a rough assumption regarding the parameter or distribution is made. H_0 stands for the null hypothesis, which is the premise. Next, an alternative hypothesis, H_α, is defined that is the opposite of the null hypothesis. To ascertain whether or not H_0 may be rejected, sample data is used in the hypothesis-testing process. The statistical inference is that the alternative hypothesis H_α is valid if H_0 is rejected.

The decision of whether a calculated temperature trend is statistically significant or not is based on hypothesis testing. The two hypotheses are taken as,

Null Hypothesis(H_0): The underlying long term trend is zero.

Alternative Hypothesis(H_α): The underlying long term trend is different from zero.

Importance of Using Hypothesis Tests in Trend Analysis

1. **Validation of Trends:** Trend analysis often involves making statements about existence of a trend in a dataset. Hypothesis testing provides a formal framework to evaluate whether the observed trend is statistically significant or could have occurred randomly.
2. **Quantifying Uncertainty:** Hypothesis tests provide measures of uncertainty associated with the trend. By calculating p-values or confidence intervals, we can assess the expectancy that the trend occurred due to random fluctuations in the data.
3. **Comparing Trends:** Hypothesis tests allow for comparisons between different trends or between observed trends and expected patterns, which is valuable for making informed decisions.

4. **Identifying Outliers:** In trend analysis, outliers or anomalous data points can transverse results and lead to incorrect conclusions about trends. Hypothesis tests can help identify outliers by assessing whether individual data points significantly deviate from the expected trend.

5. **Decision Making:** Hypothesis testing provides a structured approach to decision making in trend analysis. By setting null and alternative hypotheses at specific significance levels, we can make objective decisions about whether to accept or reject a proposed trend.

CHAPTER 3

RESULTS AND EXAMINATION

In this chapter we have examined and illustrated the results of our analysis of each segmented data frame on the specific time interval. For a better countenance, all the data are stated in a common manner.

3.1 The Trend of Temperature

Yearly Mean Temperature

By overviewing the Yearly mean daily Temperature from 1998 to 2022 , the average mean temperature was 25.274°C with maximum and minimum temperature of 26.120°C at year 1999 and 24.420°C at year 2018 respectively.

In Regression analysis, the slope is -0.009 and the intercept is 25.406 [Figure:3] which means according to the regression models used, the temperature in 1998 is 25.406°C. So the linear regression line is $y = -0.009x + 25.406$, and R^2 value is 0.030 .

In terms of Mann-Kendall and Sen's Slope test, we notice a decreasing trend with the p-value 0.761 which is much greater than the level of significance (0.05/5%). Also the value of the trend is -0.005 which is the value of Q in Sen's Slope test.

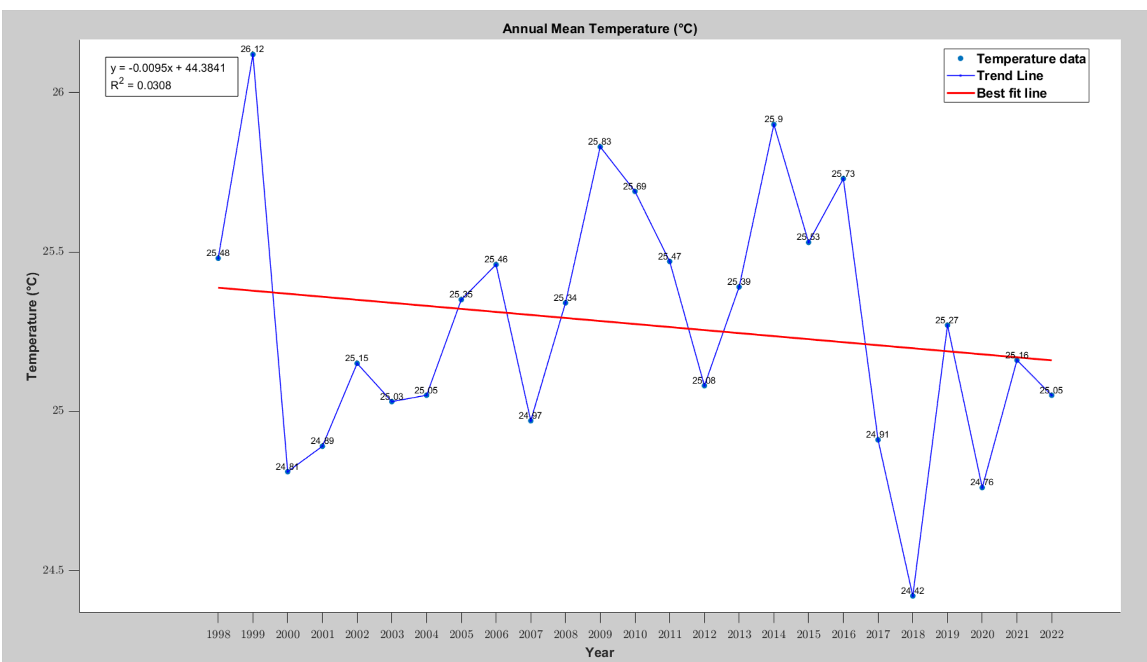

Figure 3: Trend of Annual Mean Temperature

Annual Mean Temperature				
Mann Kendall Trend Test		**Trend**	**Sen's Slope**	
S	-13.00	Decreasing	**Q**	-0.0053
Var(S)	1833.28	**Confidence Level**		
Z(S)	-0.3036	95%		

Table 3: Mann-Kendall and Sen's Slope of Annual Mean Temperature

From the Regression plot alongside Mann-Kendall and Sen's Slope test, there is a downward trend in annual mean temperature but hypothesis test fails to detect any trend in dataset with 95% of confidence level. In conclusion, there is downward trend but very low.

Yearly Maximum Temperature

For the the Yearly Maximum Temperature from 1998 to 2022 , the average maximum temperature was 33.126°C with maximum and minimum of Yearly Maximum temperature 38.090°C at year 1999 and 29.760°C at year 2017 respectively.

In Regression analysis, the slope is -0.096 and the intercept is 34.478 [Figure:4] which means according to the regression models used, the temperature in 1998 is 34.478°C. So the linear regression line is $y = -0.096x + 34.478$, and R^2 value is 0.174 .

In terms of Mann-Kendall and Sen's Slope test, we notice a decreasing trend with the p-value 0.0471 which is slightly lower than the level of significance (0.05/5%). Also the value of the trend is -0.069 which is the value of Q in Sen's Slope test.

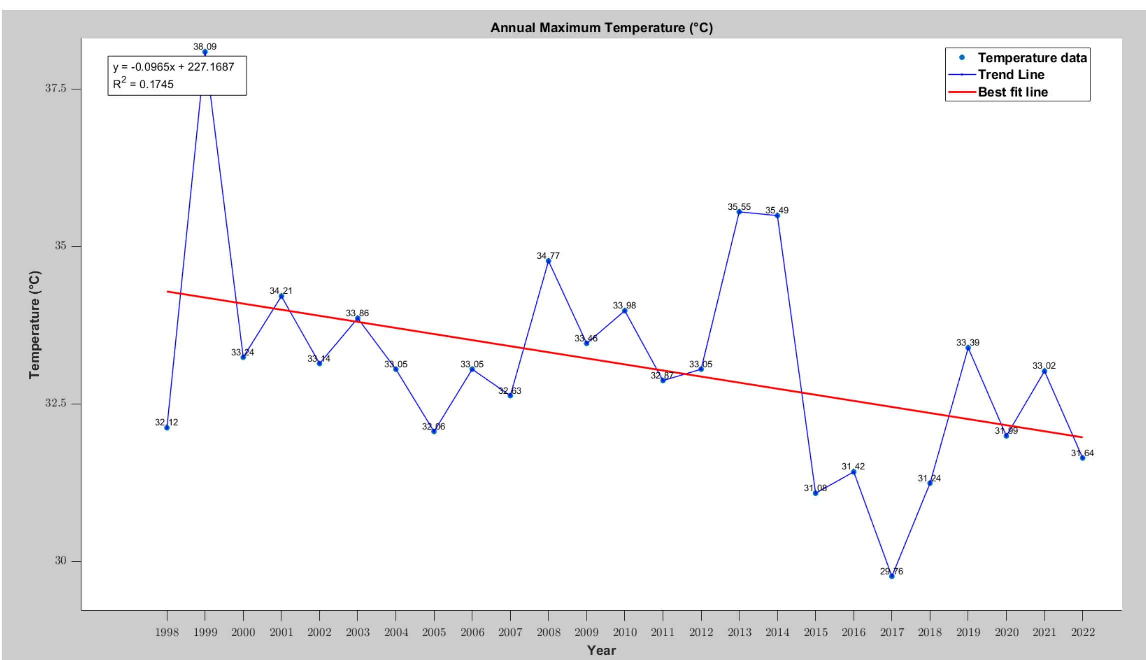

Figure 4: Trend of Annual Maximum Temperature

<table>
<tr><th colspan="5">Annual Maximum Temperature</th></tr>
<tr><th colspan="2">Mann Kendall Trend Test</th><th>Trend</th><th colspan="2">Sen's Slope</th></tr>
<tr><td>S</td><td>-85.00</td><td>Decreasing</td><td rowspan="3">Q</td><td rowspan="3">-0.0696</td></tr>
<tr><td>Var(S)</td><td>1833.16</td><td>Confidence Level</td></tr>
<tr><td>Z(S)</td><td>-1.9852</td><td>95%</td></tr>
</table>

Table 4: Mann-Kendall and Sen's Slope of Annual Maximum Temperature

From the Regression plot alongside Mann-Kendall and Sen's Slope test, there is a downward trend in annual maximum temperature and hypothesis test detects a downward trend with 95% of confidence level. In conclusion, as the p-value is slightly lower that α the downward trend is very low yet existing.

Yearly Minimum Temperature

For the the Yearly Minimum Temperature from 1998 to 2022 , the average minimum temperature was 13.822°C with maximum and minimum of Yearly Minimum temperature 16.010°C at year 1999 and 10.330°C at year 2013 respectively.

In Regression analysis, the slope is -0.038 and the intercept is 14.367 [Figure:5] which means according to the regression models used, the temperature in 1998 is 14.367°C. So the linear regression line is $y = -0.038x + 14.367$, and R^2 value is 0.0528 .

In terms of Mann-Kendall and Sen's Slope test, we notice a decreasing trend with the p-value 0.5436 which is much higher than the level of significance (0.05/5%). Also the value of the trend is -0.018 which is the value of Q in Sen's Slope test.

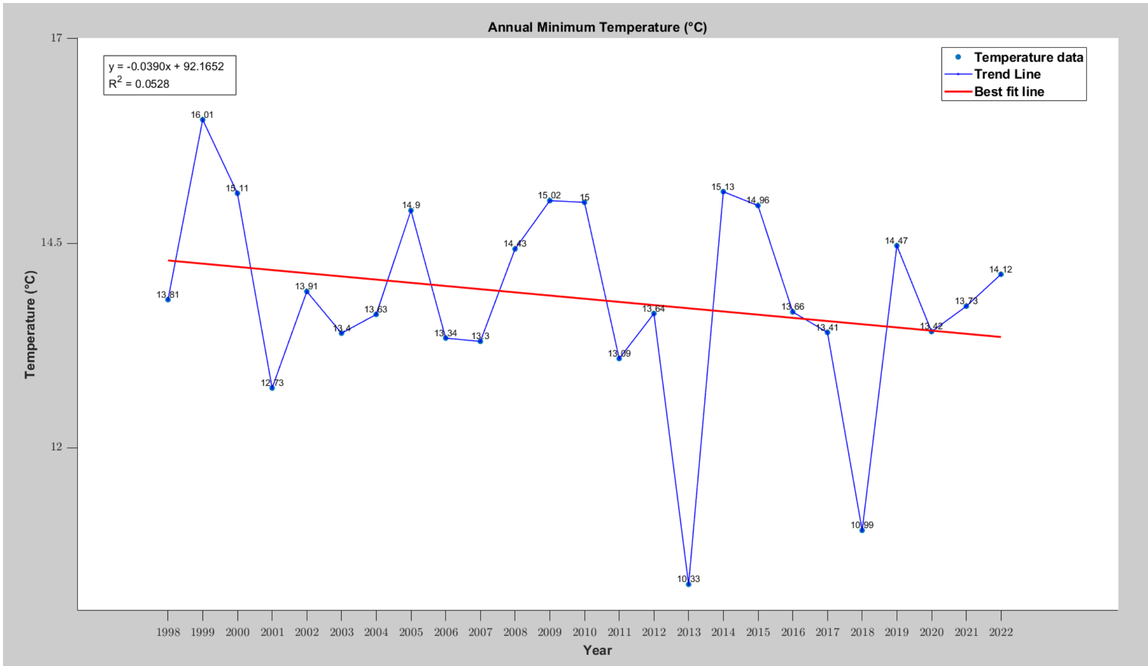

Figure 5: Trend of Annual Minimum Temperature

Annual Minimum Temperature				
Mann Kendall Trend Test		**Trend**	**Sen's Slope**	
S	-26.00	Decreasing	**Q**	-0.0189
Var(S)	1833.33	**Confidence Level**		
Z(S)	-0.607	95%		

Table 5: Mann-Kendall and Sen's Slope of Annual Minimum Temperature

From the Regression plot alongside Mann-Kendall and Sen's Slope test, there is a downward trend in annual minimum temperature and hypothesis test fails to detect any significant trend with 95% of confidence level. In conclusion, the downward trend is negligible.

Seasonal Analysis of Temperature

Annual mean temperature in Summer season

For the the Yearly mean Temperature in Summer season from 1998 to 2022 , the mean temperature was 28.776°C with maximum and minimum of Yearly Mean temperature 31.210°C at year 1999 and 26.610°C at year 2017 respectively.

In Regression analysis, the slope is -0.040 and the intercept is 29.342 [Figure:6] which means according to the regression models used, the temperature in 1998 is 29.342°C. So the linear regression line is $y = -0.040x + 29.342$, and R^2 value is 0.0890 .

In terms of Mann-Kendall and Sen's Slope test, we notice a decreasing trend with the p-value 0.623 which is greater than the level of significance (0.05/5%). Also the value of the trend is -0.0125 which is the value of Q in Sen's Slope test.

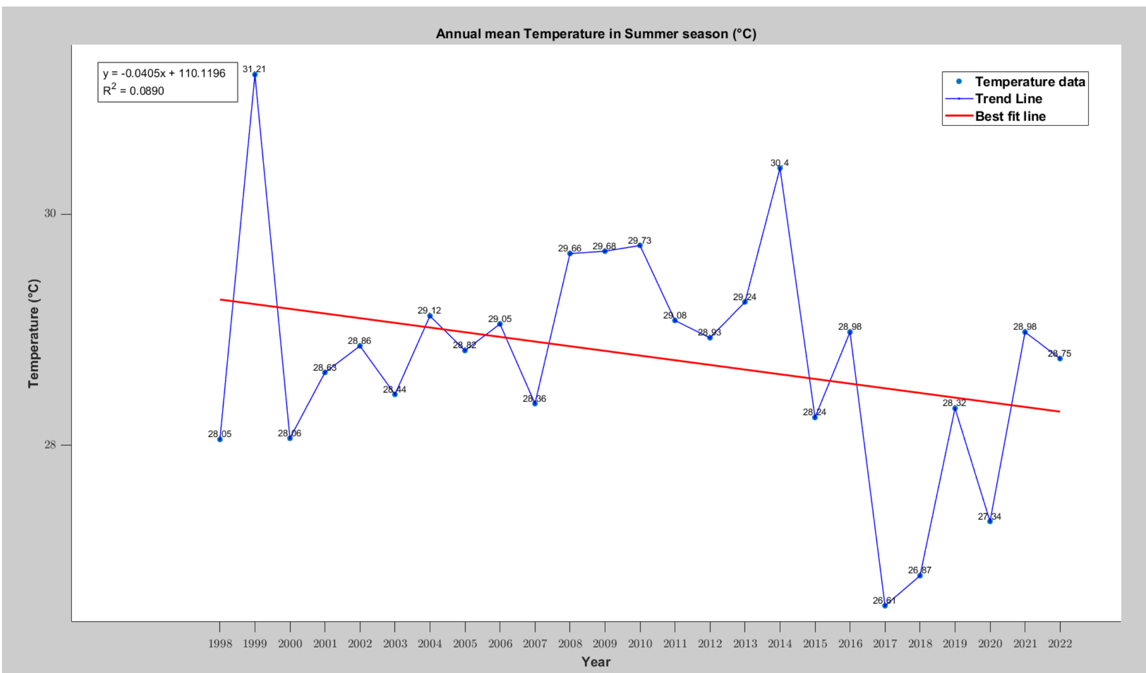

Figure 6: Trend of Annual mean Temperature in Summer

<table>
<tr><th colspan="6">Annual Mean Temperature in Summer</th></tr>
<tr><th colspan="2">Mann Kendall Trend Test</th><th>Trend</th><th colspan="2">Sen's Slope</th></tr>
<tr><td>S</td><td>-21.00</td><td>Decreasing</td><td rowspan="3">Q</td><td rowspan="3">-0.0125</td></tr>
<tr><td>Var(S)</td><td>1833.27</td><td>Confidence Level</td></tr>
<tr><td>Z(S)</td><td>-0.490</td><td>95%</td></tr>
</table>

Table 6: Mann-Kendall and Sen's Slope of Annual mean Temperature in summer

From the Regression plot alongside Mann-Kendall and Sen's Slope test, there is a downward trend in annual mean temperature but hypothesis test fails to detect any trend with 95% of confidence level. In conclusion, there is a low downward trend in mean temperature of summer.

Annual mean temperature in Monsoon

For the the Yearly mean Temperature in Monsoon from 1998 to 2022 , the mean temperature was 28.281°C with maximum and minimum of Yearly Mean temperature 28.634°C at year 2009 and 27.944°C at year 2004 respectively.

In Regression analysis, the slope is 0.0063 and the intercept is 28.192 [Figure:7] which means according to the regression models used, the temperature in 1998 is 28.192°C. So the linear regression line is $y = 0.0063x + 28.192$, and R^2 value is 0.0599 .

In terms of Mann-Kendall and Sen's Slope test, we notice a increasing trend with the p-value 0.2245 which is greater than the level of significance (0.05/5%). Also the value of the trend is 0.0055 which is the value of Q in Sen's Slope test.

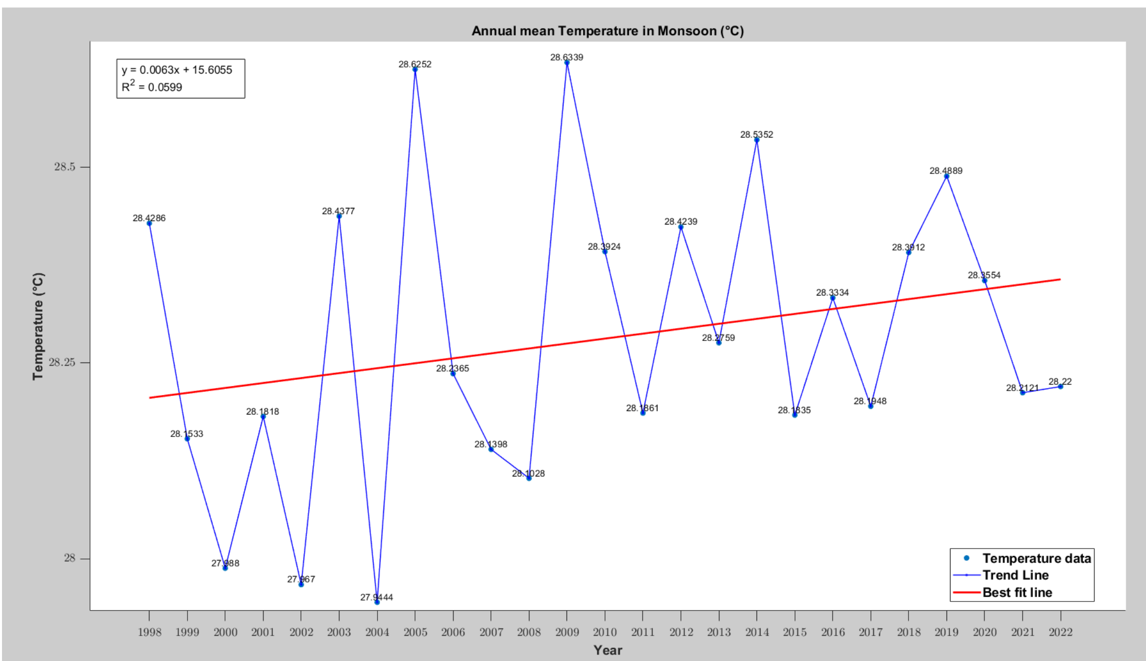

Figure 7: Trend of Annual mean Temperature in Monsoon

Annual Mean Temperature in Monsoon				
Mann Kendall Trend Test		**Trend**	**Sen's Slope**	
S	52.00	Increasing	**Q**	0.0056
Var(S)	1833.33	**Confidence Level**		
Z(S)	1.2144	95%		

Table 7: Mann-Kendall and Sen's Slope of Annual mean Temperature in monsoon

From the Regression plot alongside Mann-Kendall and Sen's Slope test, we notice a trivial value of Q. However, there is a upward trend in annual mean temperature but hypothesis test fails to detect any trend with 95% of confidence level. In conclusion, the upward trend is quite low in monsoon.

Annual mean temperature in Post-Monsoon

For the the Yearly mean Temperature in Post-Monsoon from 1998 to 2022 , the mean temperature was 23.717°C with maximum and minimum of Yearly Mean temperature 24.872°C at year 1998 and 22.660°C at year 2004 respectively.

In Regression analysis, the slope is 0.0117 and the intercept is 23.553 [Figure:8] which means according to the regression models used, the temperature in 1998 is 23.553°C. So the linear regression line is $y = 0.0117x + 23.553$, and R^2 value is 0.0226 .

In terms of Mann-Kendall and Sen's Slope test, we notice a increasing trend with the p-value 0.3266 which is greater than the level of significance (0.05/5%). Also the value of the trend is 0.0163 which is the value of Q in Sen's Slope test.

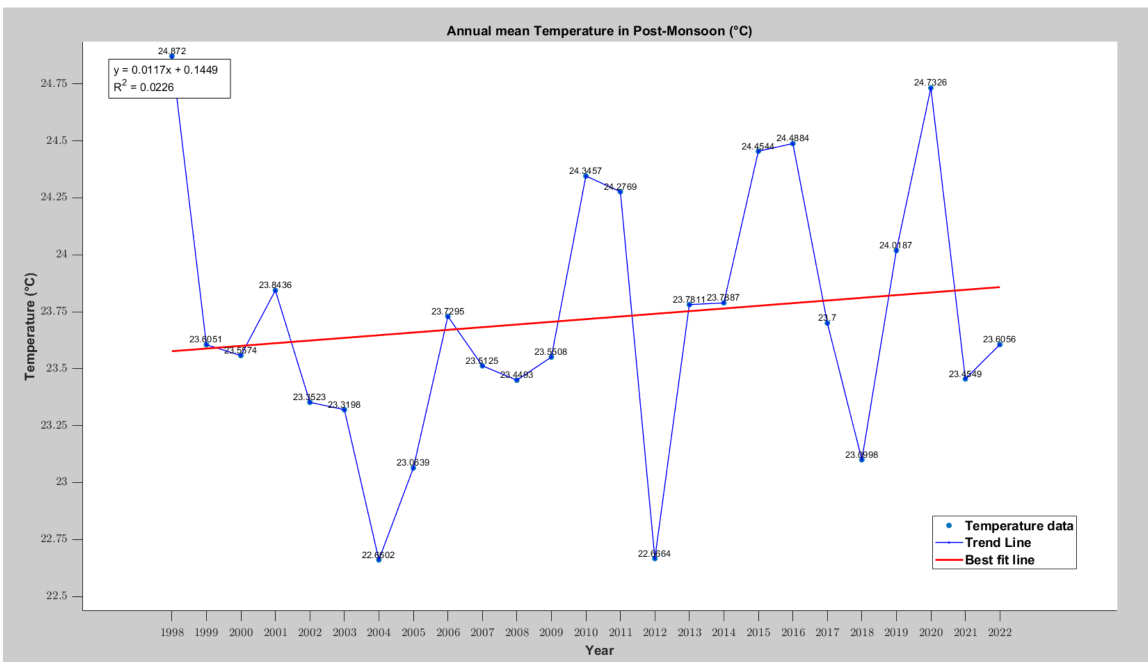

Figure 8: Trend of Annual mean Temperature in Post-Monsoon

<table>
<tr><th colspan="5">Annual Mean Temperature in Post-Monsoon</th></tr>
<tr><th colspan="2">Mann Kendall Trend Test</th><th>Trend</th><th colspan="2">Sen's Slope</th></tr>
<tr><td>S</td><td>42.00</td><td>Increasing</td><td rowspan="3">Q</td><td rowspan="3">0.0163</td></tr>
<tr><td>Var(S)</td><td>1833.33</td><td>Confidence Level</td></tr>
<tr><td>Z(S)</td><td>0.980</td><td>95%</td></tr>
</table>

Table 8: Mann-Kendall and Sen's Slope of Annual mean Temperature in post-monsoon

From the Regression plot alongside Mann-Kendall and Sen's Slope test, there is a upward trend in annual mean temperature but hypothesis test fails to detect any trend with 95% of confidence level. In conclusion, the upward trend is minimum in terms of post-monsoon mean temperature analysis.

Annual mean temperature in Winter season

For the the Yearly mean Temperature in Winter from 1998 to 2022 , the mean temperature was 18.683°C with maximum and minimum of Yearly Mean temperature 19.885°C at year 2015 and 17.312°C at year 2001 respectively.

In Regression analysis, the slope is -0.0137 and the intercept is 18.876 [Figure:9] which means according to the regression models used, the temperature in 1998 is 18.876°C. So the linear regression line is $y = -0.0137x + 18.876$, and R^2 value is 0.0179 .

In terms of Mann-Kendall and Sen's Slope test, we notice a increasing trend with the p-value 0.6073 which is greater than the level of significance (0.05/5%). Also the value of the trend is -0.0088 which is the value of Q in Sen's Slope test.

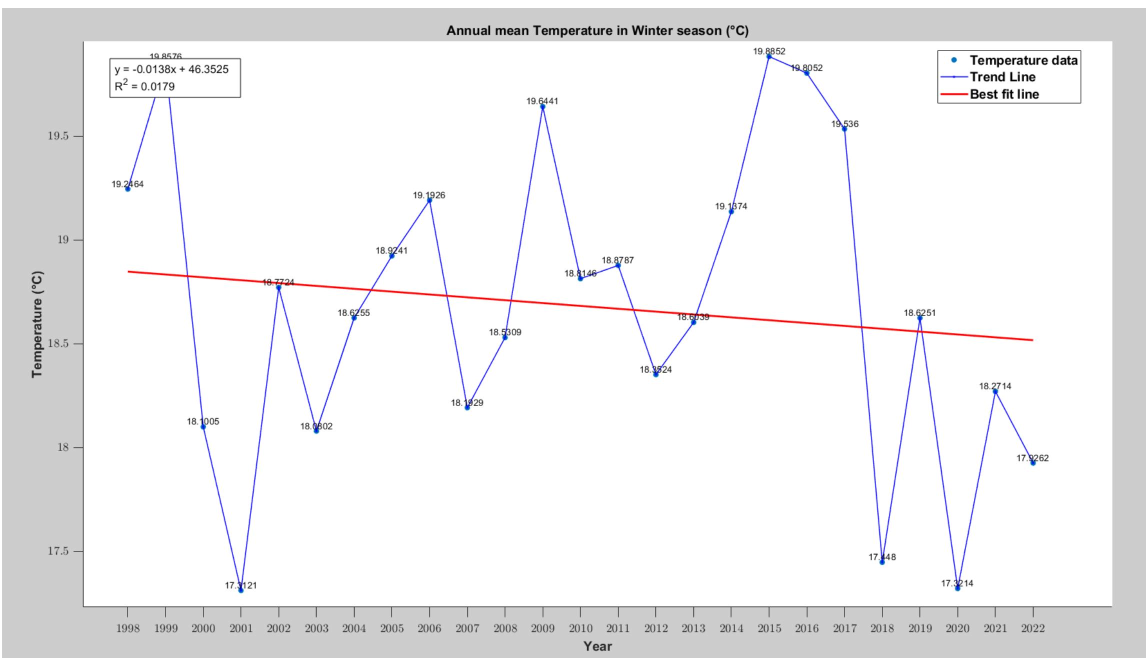

Figure 9: Trend of Annual mean Temperature in Winter Season

Table 9: Mann-Kendall and Sen's Slope of Annual mean Temperature in winter season

From the Regression plot alongside Mann-Kendall and Sen's Slope test, the Q value is very low; there is a downward trend in annual mean temperature but hypothesis test fails to detect

Annual Mean Temperature in Winter season					
Mann Kendall Trend Test		Trend	Sen's Slope		
S	-22.00	Decreasing	**Q**		-0.0088
Var(S)	1833.33	**Confidence Level**			
Z(S)	-0.5138	95%			

any trend with 95% of confidence level. In conclusion, the downward trend of mean yearly temperature is very low in winter.

Annual Mean Temperature Comparison throughout Seasonal Periods

We have generated a Bar Diagram [Figure:10] to compare temperatures of the four seasons. Conventionally, Summer has the highest temperatures among all seasons in most of our study years, followed by Monsoon. The winter season has consistently maintained a lower temperature series, which is quite obvious in Bangladesh.

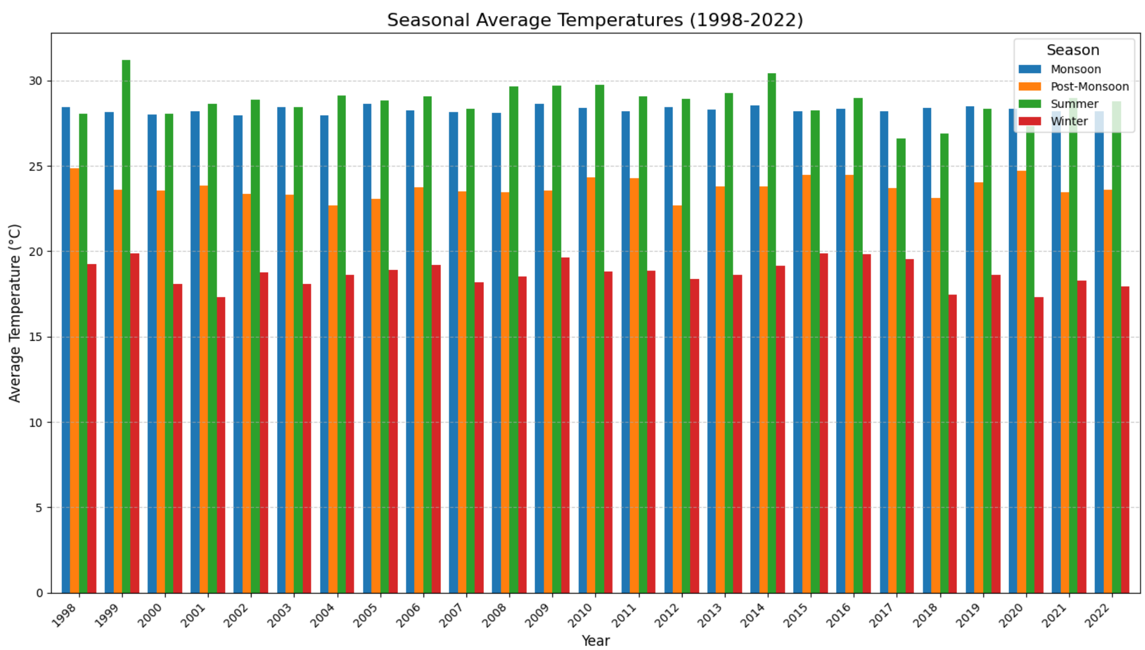

Figure 10: Comparison of temperatures throughout the seasons

Average Temperature in Seasons

From the bar plot shown in [Figure:11] it is observed that the Summer has highest average temperature of 28.7822°C and the lowest temperature is in Winter with 18.6834°C.

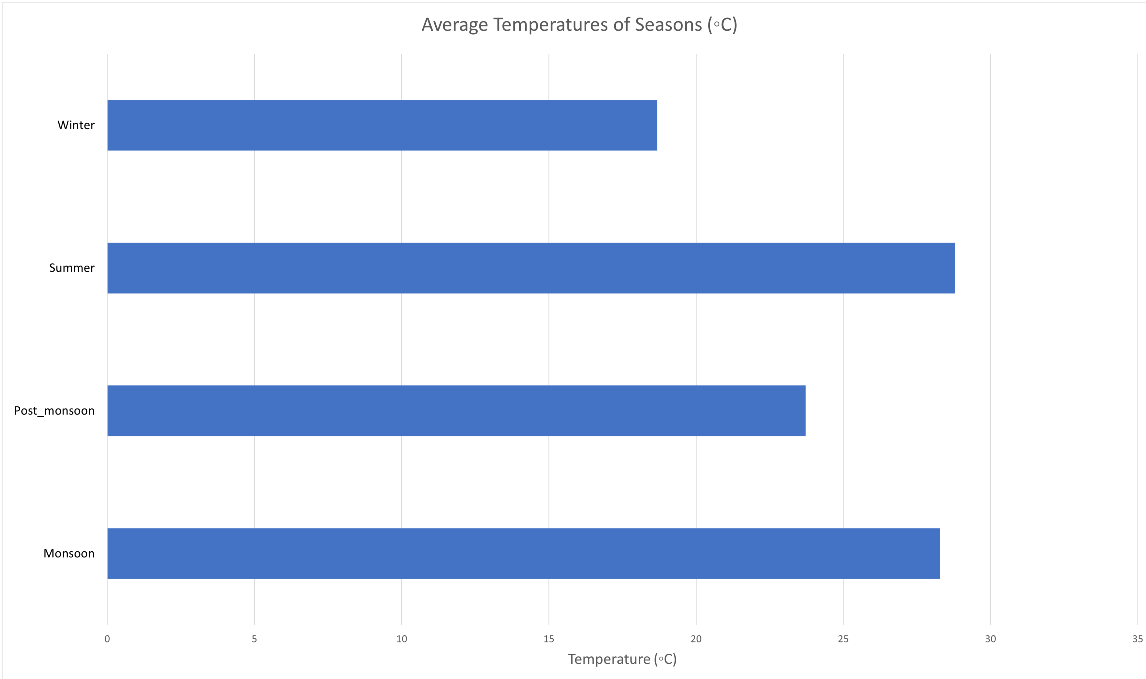

Figure 11: Average temperatures of the seasons

3.2 The Trend of Relative Humidity (RH)

Yearly Mean Relative Humidity

The data of Relative Humidity in % per day shows the maximum mean humidity was 80.310% in year 2017 whereas the minimum was 69.560% in year 1999 with the average mean humidity of 74.864%.
The Regression analysis gives us the regression line slope 0.2256 with an intercept of 71.704 [Figure:12]. Therefore the Relative humidity was 71.704% in 1998 according to regression model. Thus the linear regression line is $y = 0.2256x + 71.704$ with R^2 value of 0.3955.
Mann-Kendall and Sen's slope test shows that there is an increasing trend in the data set. Also the p-value is 0.00628 which is much less that our predetermined significance level (0.05/5%). The value of this trend is 0.2179 which is the value of Q in Sen's Slope test.

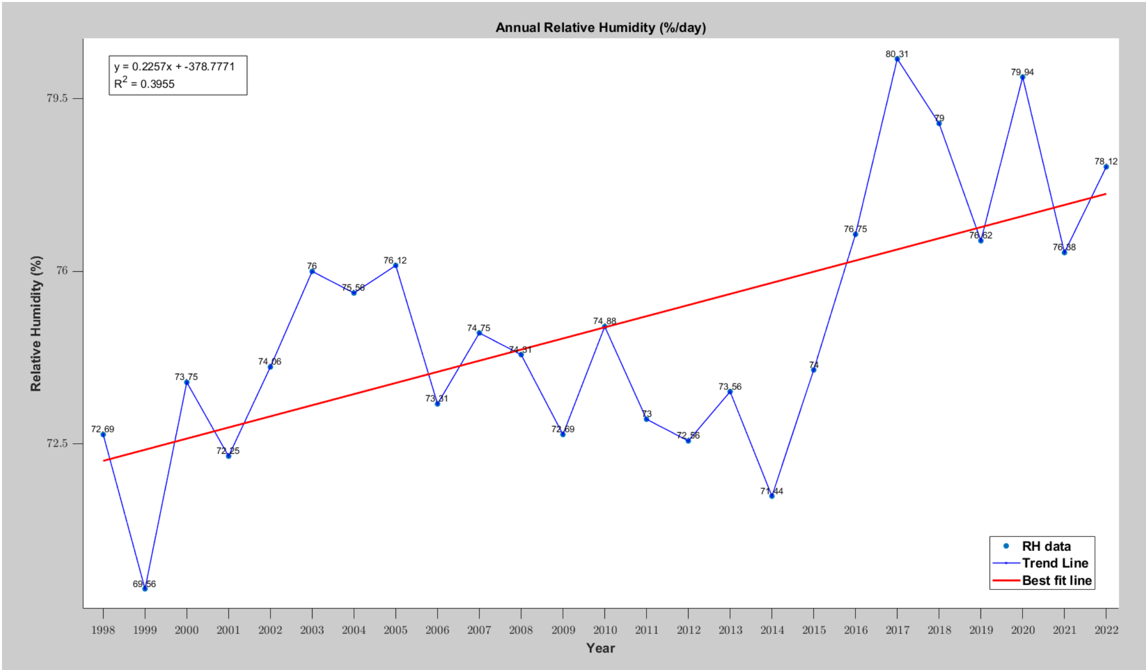

Figure 12: Average Yearly Relative Humidity

Annual Mean Relative Humidity				
Mann Kendall Trend Test		**Trend**	**Sen's Slope**	
S	117.00	Increasing	**Q**	0.2180
Var(S)	1833.27	**Confidence Level**		
Z(S)	2.7325	95%		

Table 10: Mann-Kendall and Sen's Slope of Annual mean Relative Humidity

From the Regression plot alongside Mann-Kendall and Sen's Slope test, there is a momentous upward trend in annual mean RH and hypothesis test also detects a positive trend with 95% of confidence level. In conclusion, there exists an upward trend for yearly mean Relative Humidity in each study.

Seasonal analysis of Relative Humidity

Annual mean Relative Humidity in Summer season

The data of Annual mean Relative Humidity of Summer in % per day shows the maximum mean humidity was 78.234% in year 2017 whereas the minimum was 47.607% in year 1999 with the average mean humidity of 62.370%.
The Regression analysis gives us the regression line slope 0.4446 with an intercept of 56.1451 [Figure:13]. Therefore the Relative humidity was 56.1451% in 1998 according to regression model. Thus the linear regression line is $y = 0.4446x + 56.1451$ with R^2 value of 0.2625.

Mann-Kendall and Sen's slope test shows that there is an increasing trend in the data set. Also the p-value is 0.0281 which is slightly less that our predetermined significance level (0.05/5%). The value of this trend is 0.3354 which is the value of Q in Sen's Slope test.

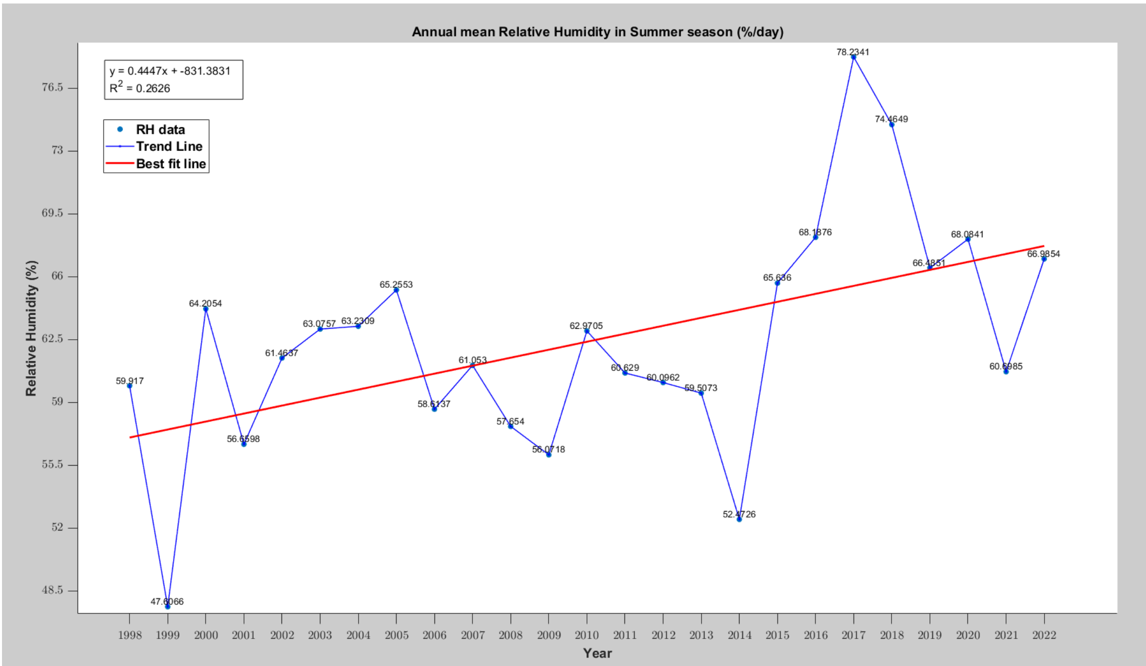

Figure 13: Average Yearly Relative Humidity in summer season

Annual Mean Relative Humidity in Summer				
Mann Kendall Trend Test		**Trend**	**Sen's Slope**	
S	94.00	Increasing	**Q**	0.3354
Var(S)	1833.33	**Confidence Level**		
Z(S)	2.1953	95%		

Table 11: Mann-Kendall and Sen's Slope of Annual mean Relative Humidity in Summer season

From the Regression plot as well as Mann-Kendall and Sen's Slope test, there is a momentous upward trend in annual mean RH in summer and hypothesis test also detects a positive trend with 95% of confidence level. In conclusion, there exists an upward trend for yearly mean Relative Humidity in each study of summer season.

Annual mean Relative Humidity in Monsoon

The data of Annual mean Relative Humidity of Monsoon in % per day shows the maximum mean humidity was 90.423% in year 2017 whereas the minimum was 86.669% in years 2005 and 2009 with the average mean humidity of 88.603%.

The Regression analysis gives us the regression line slope 0.036 with an intercept of 88.091

[Figure:14]. Therefore the Relative humidity was 88.091% in 1998 according to regression model. Thus the linear regression line is $y = 0.036x + 88.091$ with R^2 value of 0.0975.
Mann-Kendall and Sen's slope test shows that there is a trivial increasing trend in the data set. Also the p-value is 0.2072 which is greater that our predetermined significance level (0.05/5%). The value of this trend is 0.0313 which is the value of Q in Sen's Slope test.

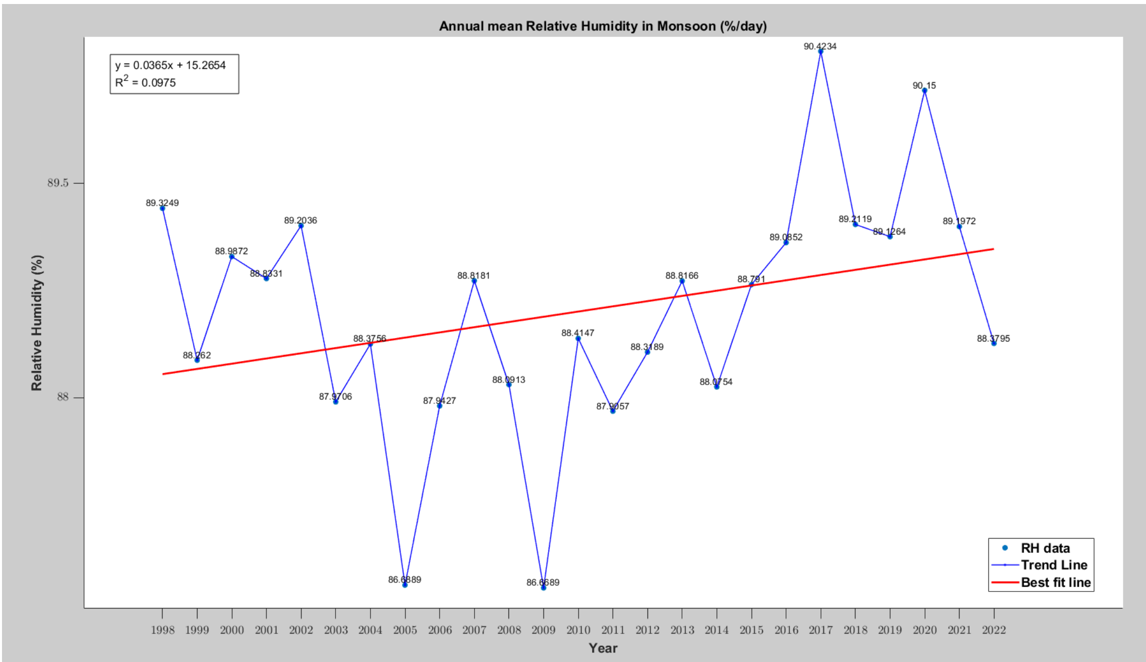

Figure 14: Average Yearly Relative Humidity in monsoon season

Annual Mean Relative Humidity in Monsoon				
Mann Kendall Trend Test		**Trend**	**Sen's Slope**	
S	54.00	Increasing	**Q**	0.0317
Var(S)	1833.33	**Confidence Level**		
Z(S)	1.2611	95%		

Table 12: Mann-Kendall and Sen's Slope of Annual mean Relative Humidity in Monsoon

From the Regression plot as well as Mann-Kendall and Sen's Slope test, there is a upward trend in annual mean RH in monsoon but hypothesis test could not detect any valid trend with 95% of confidence level. In conclusion, there exists an increasing upward trend for yearly mean Relative Humidity of monsoon according to only Slope test.

Annual mean Relative Humidity in Post-Monsoon

The data of Annual mean Relative Humidity of Post-Monsoon in % per day shows the maximum mean humidity was 84.503% in year 2020 whereas the minimum was 77.190% in year 2011 with

the average mean humidity of 81.768%.
The Regression analysis gives us the regression line slope 0.0106 with an intercept of 81.6193 [Figure:15]. Therefore the Relative humidity was 81.6193% in 1998 according to regression model. Thus the linear regression line is $y = 0.0106x + 81.6193$ with R^2 value of 0.0011.
Mann-Kendall and Sen's slope test shows that there is an increasing trend in the data set. Also the p-value is 0.40 which is greater that our predetermined significance level (0.05/5%). The value of this trend is 0.0446 which is the value of Q in Sen's Slope test.

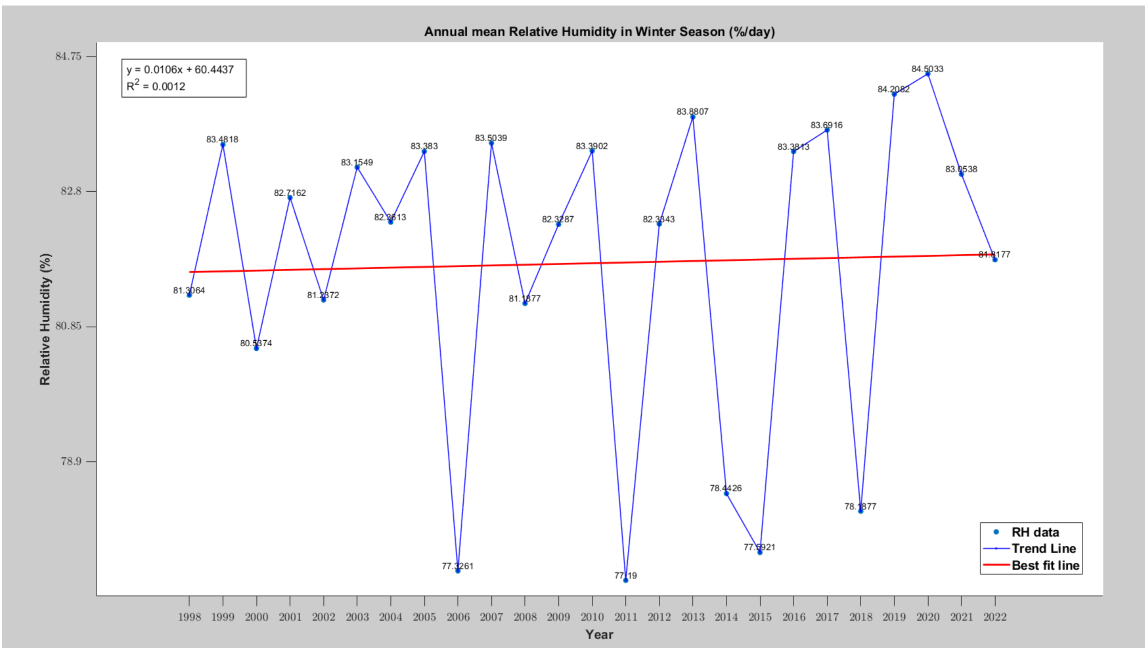

Figure 15: Average Yearly Relative Humidity in post monsoon season

<table>
<tr><th colspan="5">Annual Mean Relative Humidity in Post-Monsoon</th></tr>
<tr><th colspan="2">Mann Kendall Trend Test</th><th>Trend</th><th colspan="2">Sen's Slope</th></tr>
<tr><td>S</td><td>36.00</td><td>Increasing</td><td rowspan="3">Q</td><td rowspan="3">0.0447</td></tr>
<tr><td>Var(S)</td><td>1833.33</td><td>Confidence Level</td></tr>
<tr><td>Z(S)</td><td>0.8407</td><td>95%</td></tr>
</table>

Table 13: Mann-Kendall and Sen's Slope of Annual mean Relative Humidity in Post-Monsoon

From the Regression plot as well as Hypothesis test, there is hardly any trend visible in annual mean RH in post-monsoon though Mann-Kendall and Sen's Slope test Calculates an increasing trend with 95% of confidence level. In conclusion, there exists no trend for yearly mean Relative Humidity of post-monsoon.

Annual mean Relative Humidity in Winter season

The data of Annual mean Relative Humidity of Winter in % per day shows the maximum mean humidity was 75.224% in year 2020 whereas the minimum was 57.195% in year 1999 with the average mean humidity of 64.368%.
The Regression analysis gives us the regression line slope 0.4043 with an intercept of 58.7075 [Figure:16]. Therefore the Relative humidity was 58.7075% in 1998 according to regression model. Thus the linear regression line is $y = 0.4043x + 58.7075$ with R^2 value of 0.3588.
Mann-Kendall and Sen's slope test shows that there is an increasing trend in the data set. Also the p-value is 0.0037 which is much less that our predetermined significance level (0.05/5%). The value of this trend is 0.3885 which is the value of Q in Sen's Slope test.

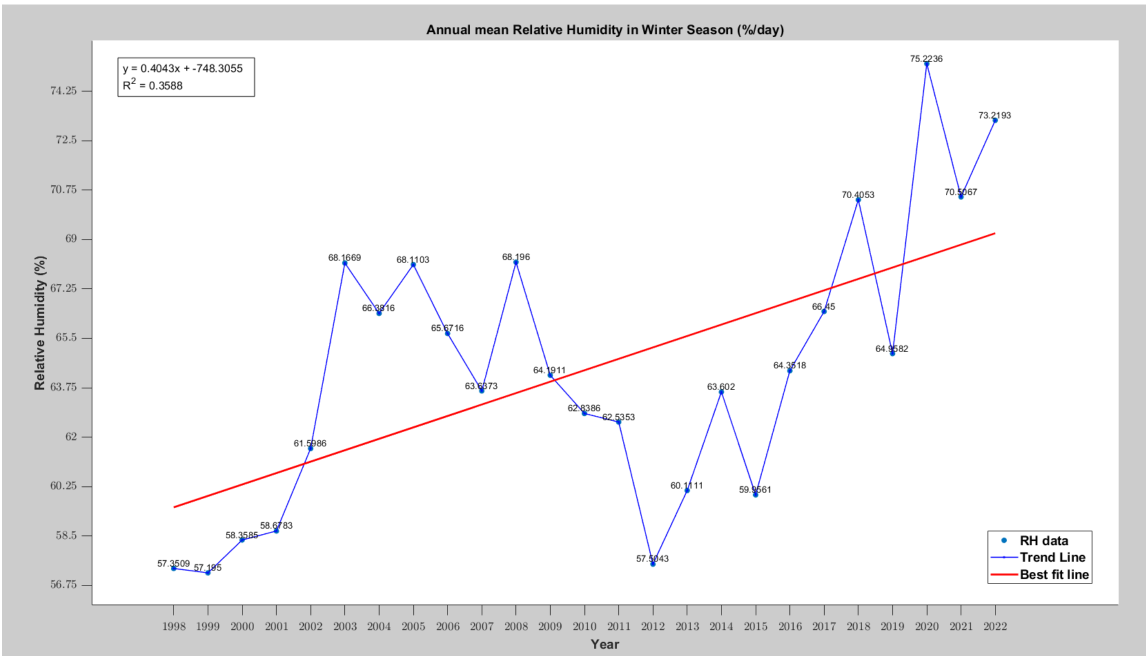

Figure 16: Average Yearly Relative Humidity in winter season

<table>
<tr><th colspan="5">Annual Mean Relative Humidity in Winter</th></tr>
<tr><th colspan="2">Mann Kendall Trend Test</th><th>Trend</th><th colspan="2">Sen's Slope</th></tr>
<tr><td>S</td><td>124.00</td><td>Increasing</td><td rowspan="3">Q</td><td rowspan="3">0.3885</td></tr>
<tr><td>Var(S)</td><td>1833.33</td><td>Confidence Level</td></tr>
<tr><td>Z(S)</td><td>2.8960</td><td>95%</td></tr>
</table>

Table 14: Mann-Kendall and Sen's Slope of Annual mean Relative Humidity in Winter season

From the Regression plot as well as Mann-Kendall and Sen's Slope test, there is a significant upward trend in annual mean RH in Winter and hypothesis test also detects a positive trend with 95% of confidence level. In conclusion, there exists an upward trend for yearly mean Relative Humidity in each analysis of winter season.

Annual Mean Relative Humidity Comparison throughout Seasonal Periods

A conventional Bar Diagram is shown [Figure:17] to compare relative humidities of the four seasons. Typically Monsoon has the highest precipitation in Bangladesh, causing the higher RH values. Monsoon is followed by post-monsoon, the season with second highest rainfall and RH. The summer and winter seasons have comparatively lower humidity because the difference in air temperature.

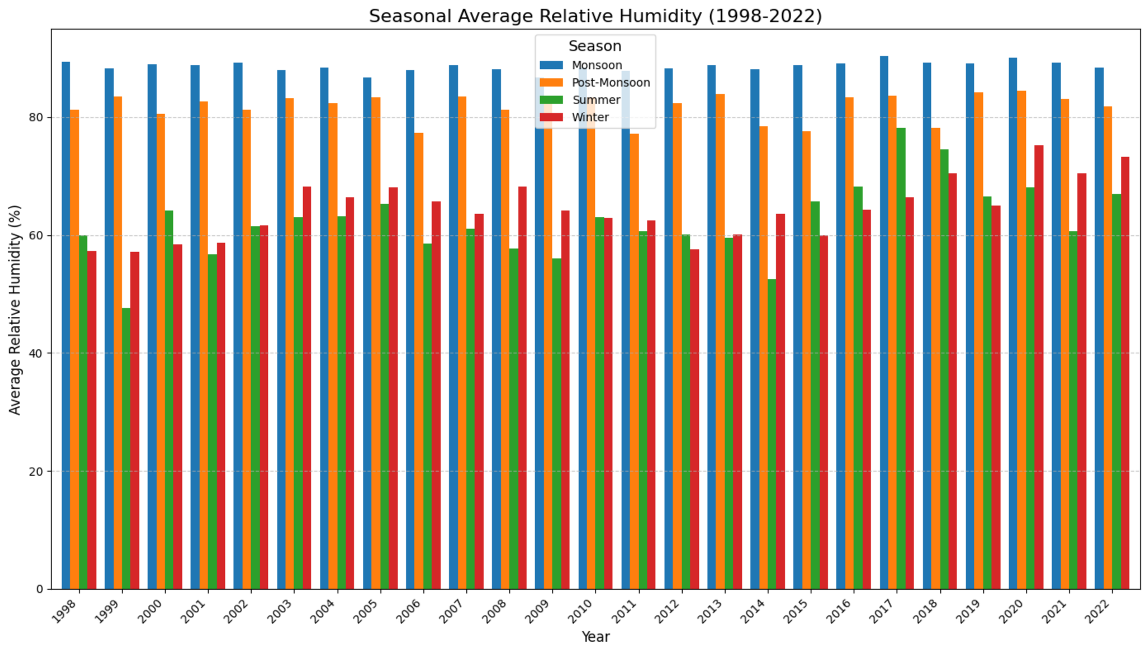

Figure 17: Comparison of RH throughout the seasons

Average Relative Humidity in Seasons

From the bar plot shown in [Figure:18] it is observed that the Monsoon has highest average RH of 88.6025% and the lowest RH is in Summer with 62.3703%.

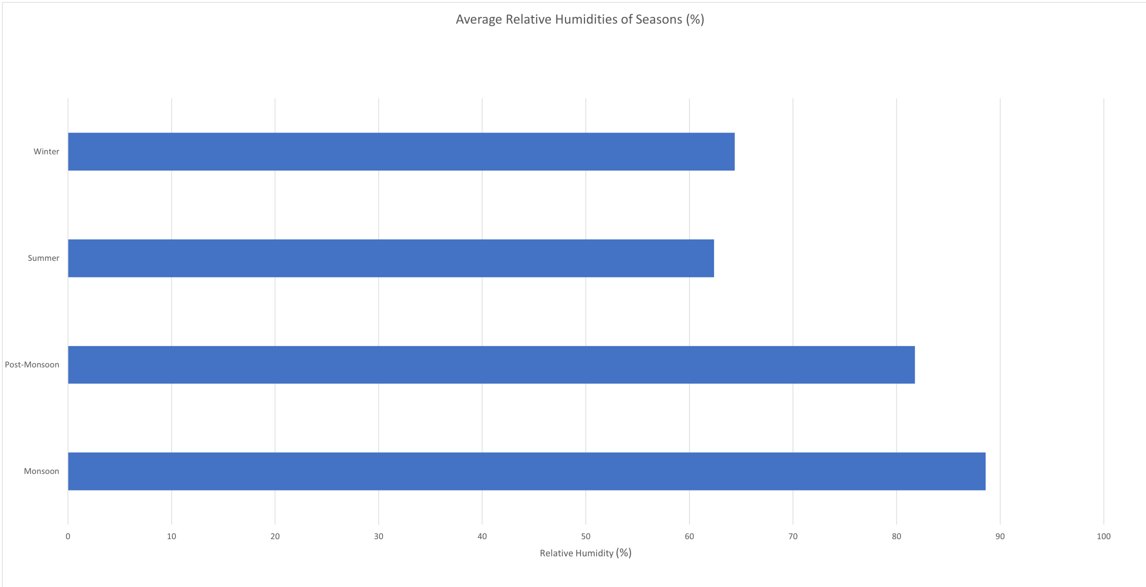

Figure 18: Average Relative Humidities of the seasons

3.3 The Trend of Dew-Point Temperature

Annual Mean Dew-Point Temperature

The dataset of Annual mean Dew-Point temperature (in°C) shows the maximum mean dew temperature was 21.050°C in year 2017 whereas the minimum was 18.240°C in year 1999 with the average mean temperature of 19.703°C.
The Regression analysis evaluates the regression line slope 0.0671 with an intercept of 18.7625 [Figure:19]. Therefore the Dew-Point temperature was 18.7625°C in 1998 according to regression model. Thus the linear regression line is $y = 0.0671x + 18.7625$ with R^2 value of 0.4838.
Mann-Kendall and Sen's slope test shows that there is a consistent increasing trend in the data set. Also the p-value is 0.0016 which is much less that our predetermined significance level (0.05/5%). The value of this trend is 0.0646 which is the value of Q in Sen's Slope test.

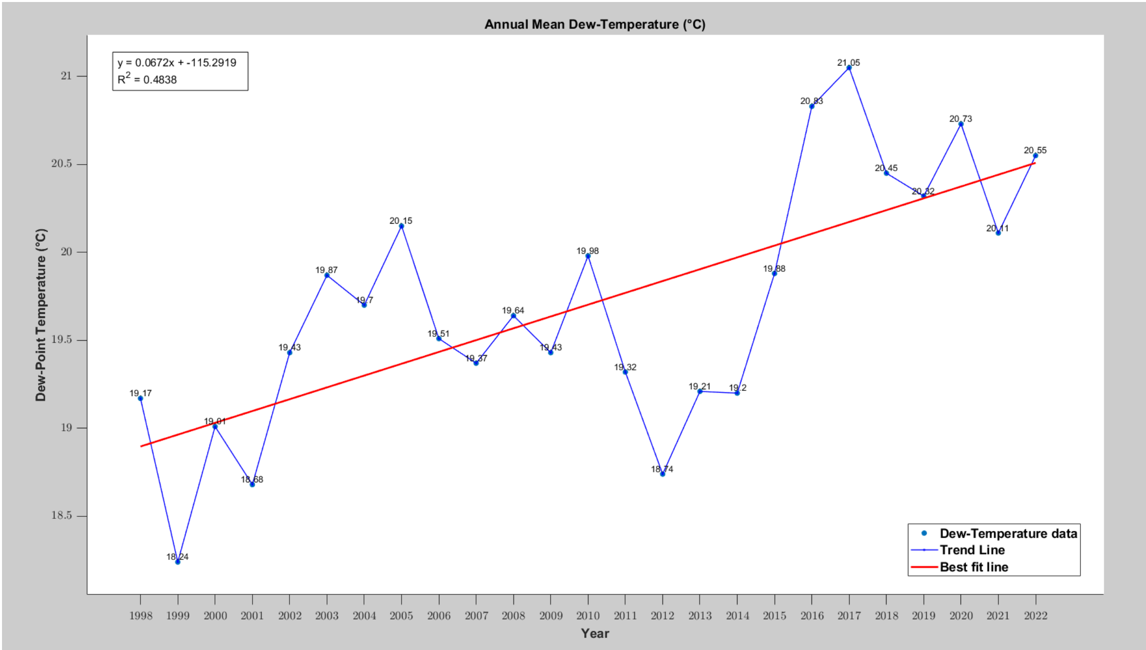

Figure 19: Average Yearly Dew-Point Temperature

Annual Mean Dew-Point Temperature				
Mann Kendall Trend Test		**Trend**	**Sen's Slope**	
S	135.00	Increasing	**Q**	0.0647
Var(S)	1833.27	**Confidence Level**		
Z(S)	3.1529	95%		

Table 15: Mann-Kendall and Sen's Slope of Annual mean Dew-Point Temperature

From the Regression plot as well as Mann-Kendall and Sen's Slope test, there is a significant upward trend in annual mean dew-point temperature and hypothesis test also detects a positive trend with 95% of confidence level. In conclusion, there exists an upward/positive trend for yearly mean dew-point temperature.

Seasonal analysis of Dew-Point Temperature

Annual mean Dew-point temperature in Summer season

The data of Annual mean Dew-point temperature of Summer shows the maximum mean temperature was 21.891°C in year 2017 whereas the minimum was 14.666°C in year 1999 with the average mean dew-point temperature of 18.920°C.
The Regression analysis gives us the regression line slope 0.1205 with an intercept of 17.2324 [Figure:20]. Therefore the dew-point temperature was 17.2324°C in 1998 according to regression model. Thus the linear regression line is $y = 0.1205x + 17.2324$ with R^2 value of 0.3351.

Mann-Kendall and Sen's slope test shows that there is an increasing trend in the data set. Also the p-value is $0.0077 < \alpha$ (0.05/5%). The value of this trend is 0.1123 which is the value of Q in Sen's Slope test.

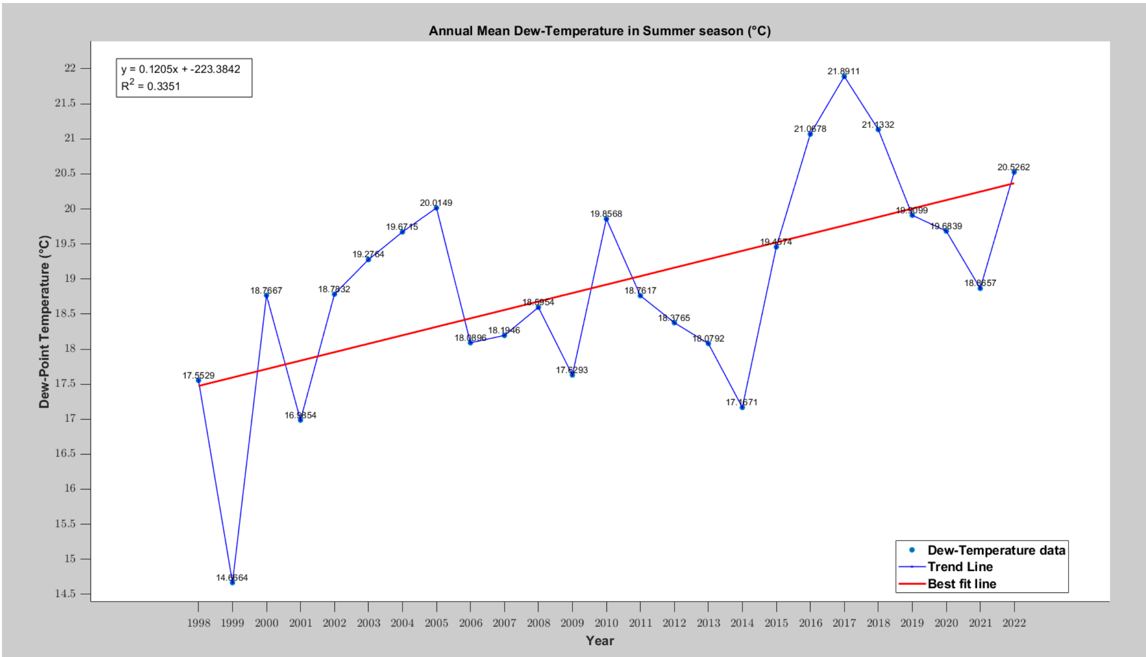

Figure 20: Average Yearly Dew-Point Temperature in summer season

Annual Mean Dew-Point temperature in Summer				
Mann Kendall Trend Test		**Trend**	**Sen's Slope**	
S	114.00	Increasing	**Q**	0.1123
Var(S)	1833.33	**Confidence Level**		
Z(S)	2.6624	95%		

Table 16: Mann-Kendall and Sen's Slope of Annual mean Dew-point temperature in Summer season

From the Regression plot as well as Mann-Kendall and Sen's Slope test, an upward trend in annual mean dew-point temperature in summer is observed, and hypothesis test also detects a positive trend with 95% of confidence level. Therefore, there exists an upward trend for yearly mean Dew-Point Temperature in summer season.

Annual mean Dew-point temperature in Monsoon

The data of Annual mean Dew-point temperature of Monsoon shows the maximum mean temperature was 26.612°C in year 2020 whereas the minimum was 25.744°C in year 2004 with the average mean dew-point temperature of 26.147°C.
The Regression analysis gives us the regression line slope 0.0177 with an intercept of 25.8981 [Figure:21]. Therefore the dew-point temperature was 25.8981°C in 1998 according to regression model. Thus the linear regression line is $y = 0.0177x + 25.8981$ with R^2 value of 0.2962.
Mann-Kendall and Sen's slope test shows that there is an positive trend in our data set. Also the p-value is $0.0013 < \alpha$ (0.05/5%). The value of this trend is 0.0234 which is the value of Q in Sen's Slope test.

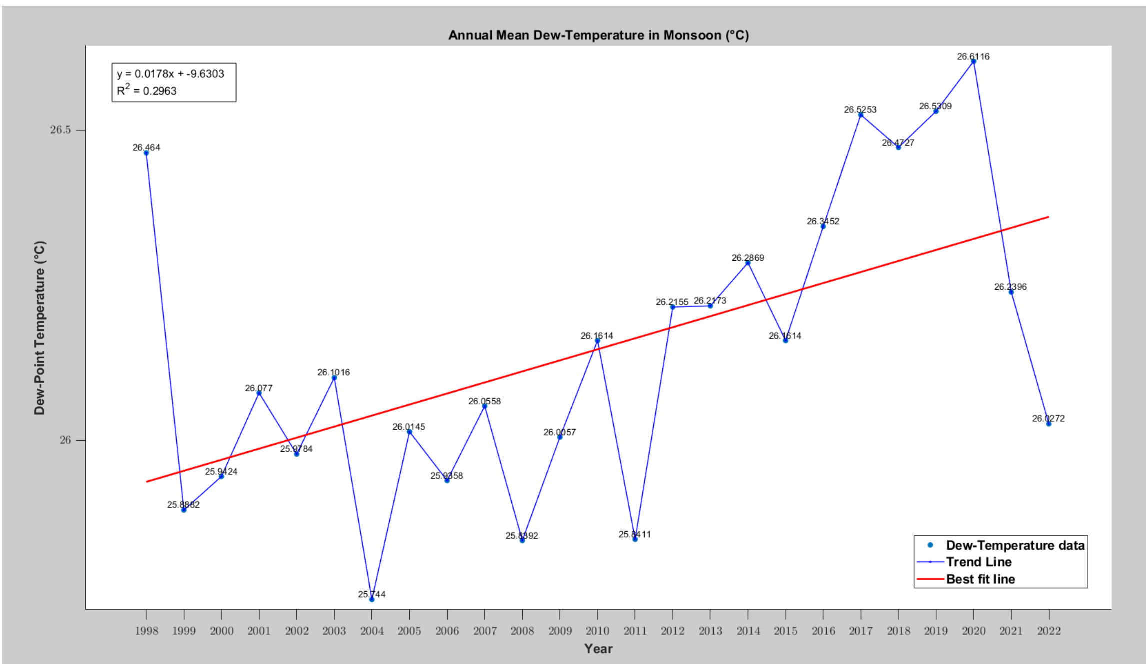

Figure 21: Average Yearly Dew-Point Temperature in monsoon

<table>
<tr><th colspan="5">Annual Mean Dew-Point temperature in Monsoon</th></tr>
<tr><th colspan="2">Mann Kendall Trend Test</th><th>Trend</th><th colspan="2">Sen's Slope</th></tr>
<tr><td>S</td><td>137.00</td><td>Increasing</td><td rowspan="3">Q</td><td rowspan="3">0.0234</td></tr>
<tr><td>Var(S)</td><td>1833.27</td><td>Confidence Level</td></tr>
<tr><td>Z(S)</td><td>3.200</td><td>95%</td></tr>
</table>

Table 17: Mann-Kendall and Sen's Slope of Annual mean Dew-point temperature in Monsoon

From the Regression plot as well as Mann-Kendall and Sen's Slope test, an upward trend in annual mean dew-point temperature in monsoon is observed, and hypothesis test also detects a positive trend with 95% of confidence level. Therefore, there exists a gradual upward trend for yearly mean Dew-Point Temperature in monsoon.

Annual mean Dew-point temperature in Post-Monsoon

The data of Annual mean Dew-point temperature of Post-Monsoon shows the maximum mean temperature was 22.168°C in year 2020 whereas the minimum was 19.419°C in year 2012 with the average mean dew-point temperature of 20.595°C.
The Regression analysis gives us the regression line slope 0.0214 with an intercept of 20.2945 [Figure:22]. Therefore the dew-point temperature was 20.2945°C in 1998 according to regression model. Thus the linear regression line is $y = 0.0214x + 20.2945$ with R^2 value of 0.050.
Mann-Kendall and Sen's slope test shows that there is an positive trend in our data set. Also the p-value is $0.374 > \alpha$ (0.05/5%). The value of this trend is 0.0187 which is the value of Q in Sen's Slope test.

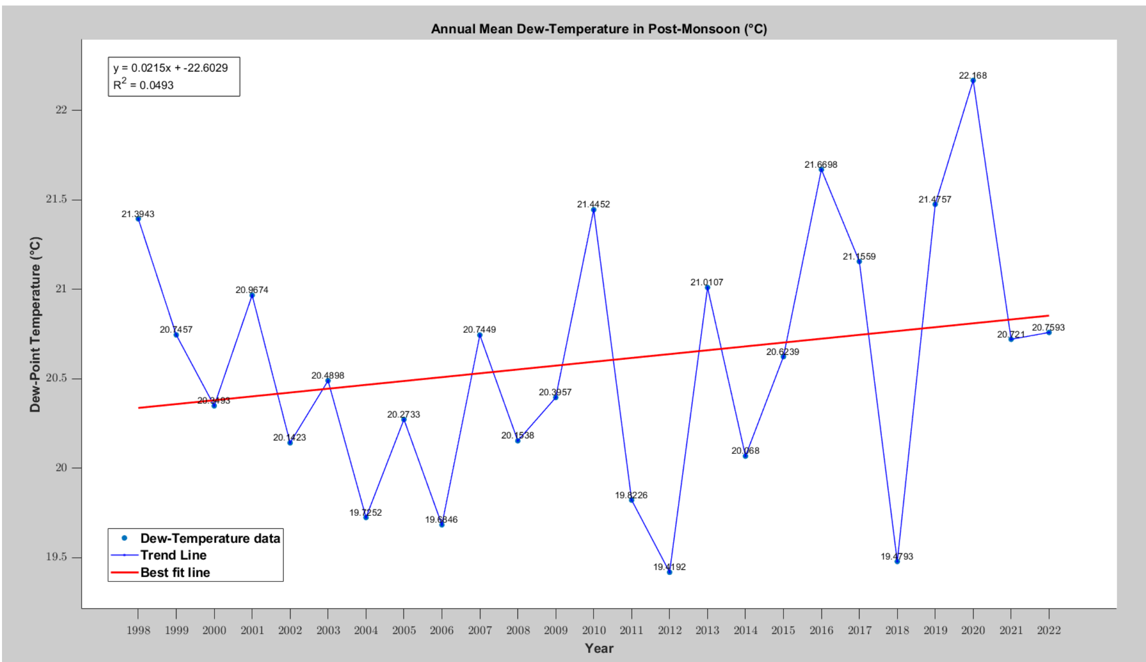

Figure 22: Average Yearly Dew-Point Temperature in post-monsoon

<table>
<tr><th colspan="6">Annual Mean Dew-Point temperature in Post-Monsoon</th></tr>
<tr><th colspan="2">Mann Kendall Trend Test</th><th>Trend</th><th colspan="3">Sen's Slope</th></tr>
<tr><td>S</td><td>38.00</td><td>Increasing</td><td rowspan="3">Q</td><td rowspan="3">0.0188</td></tr>
<tr><td>Var(S)</td><td>1833.27</td><td>Confidence Level</td></tr>
<tr><td>Z(S)</td><td>0.8874</td><td>95%</td></tr>
</table>

Table 18: Mann-Kendall and Sen's Slope of Annual mean Dew-point temperature in Post-Monsoon

From the Regression plot as well as Mann-Kendall and Sen's Slope test, an slight upward trend in annual mean dew-point temperature in post-monsoon is observed, but hypothesis test fails to detect any trend with 95% of confidence level. Therefore, there exists a upward trend for yearly mean Dew-Point Temperature in post-monsoon by only regression analysis.

Annual mean Dew-point temperature in Winter season

The data of Annual mean Dew-point temperature of winter season shows the maximum mean temperature was 12.999°C in year 2022 whereas the minimum was 8.640°C in year 2012 with the average mean dew-point temperature of 11.182°C.
The Regression analysis gives us the regression line slope 0.1106 with an intercept of 9.6337 [Figure:23]. Therefore the dew-point temperature was 9.6337°C in 1998 according to regression model. Thus the linear regression line is $y = 0.1106x + 9.6337$ with R^2 value of 0.374.
Mann-Kendall and Sen's slope test shows that there is an increasing trend in our data set. Also the p-value is 0.0012 $<< \alpha$ (0.05/5%). The value of this trend is 0.10 which is the value of Q in Sen's Slope test.

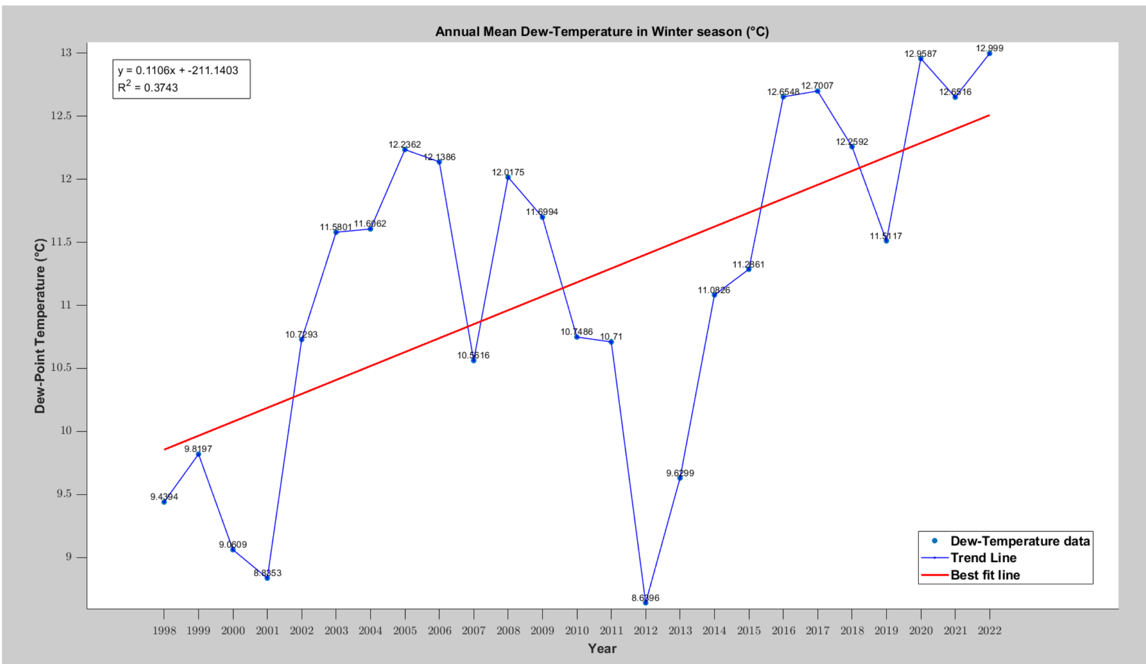

Figure 23: Average Yearly Dew-Point Temperature in Winter season

Annual Mean Dew-Point temperature in Winter				
Mann Kendall Trend Test		**Trend**	**Sen's Slope**	
S	138.00	Increasing	**Q**	0.100
Var(S)	1833.33	**Confidence Level**		
Z(S)	3.223	95%		

Table 19: Mann-Kendall and Sen's Slope of Annual mean Dew-point temperature in Winter season

From the Regression plot as well as Mann-Kendall and Sen's Slope test, an upward trend in annual mean dew-point temperature in winter is observed, also the hypothesis test detects an upward trend with 95% of confidence level. Therefore, there exists a strong upward trend for yearly mean Dew-Point Temperature in winter.

Annual Mean Dew-Point Comparison throughout Seasonal Periods

A conventional Bar Diagram is shown [Figure:24] to compare yearly mean dew-point temperature of the four seasons. In Monsoon the water holding capacity of the air is minimum, causing the dew-point temperature to rise to the highest. Like we found in Relative humidity analysis, monsoon is followed by post-monsoon. The summer's dew temperature exceeds post monsoon only in year 2017 and 2018, which are exceptions. The dew temperature of winter was never observed to cross 15°C.

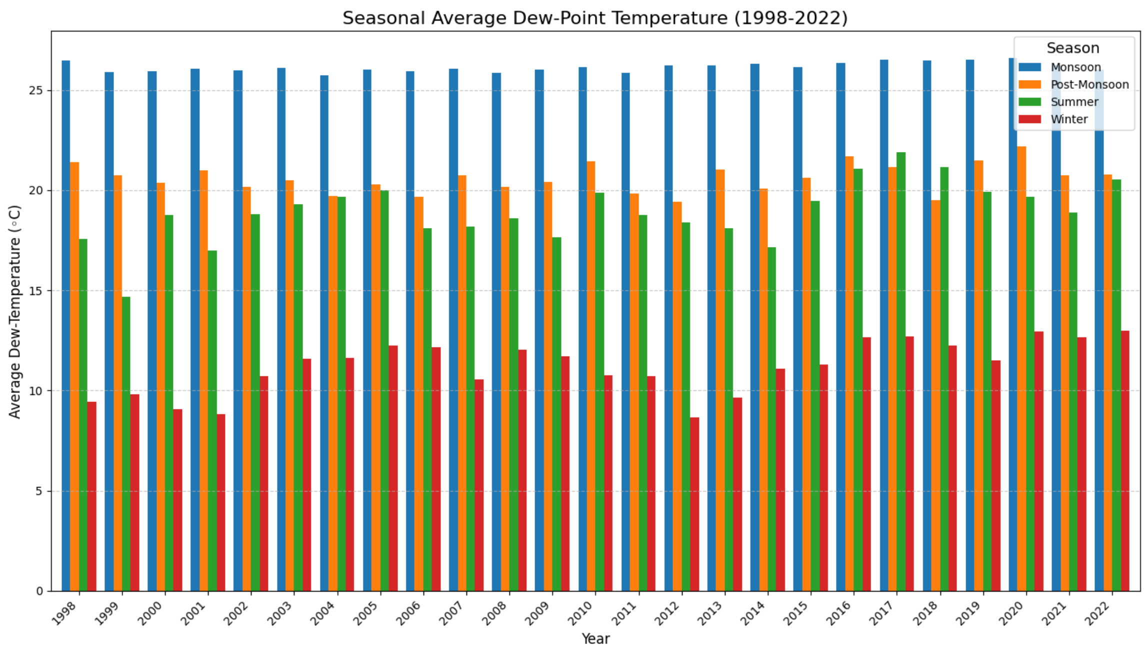

Figure 24: Comparison of Dew-Point Temperature throughout the seasons

Average Dew-Point Temperature in Seasons

From the bar plot shown in [Figure:25] it is observed that the Monsoon has highest average dew temperature of 26.1473°C and the lowest dew temperature is in Winter with 11.1822°C.

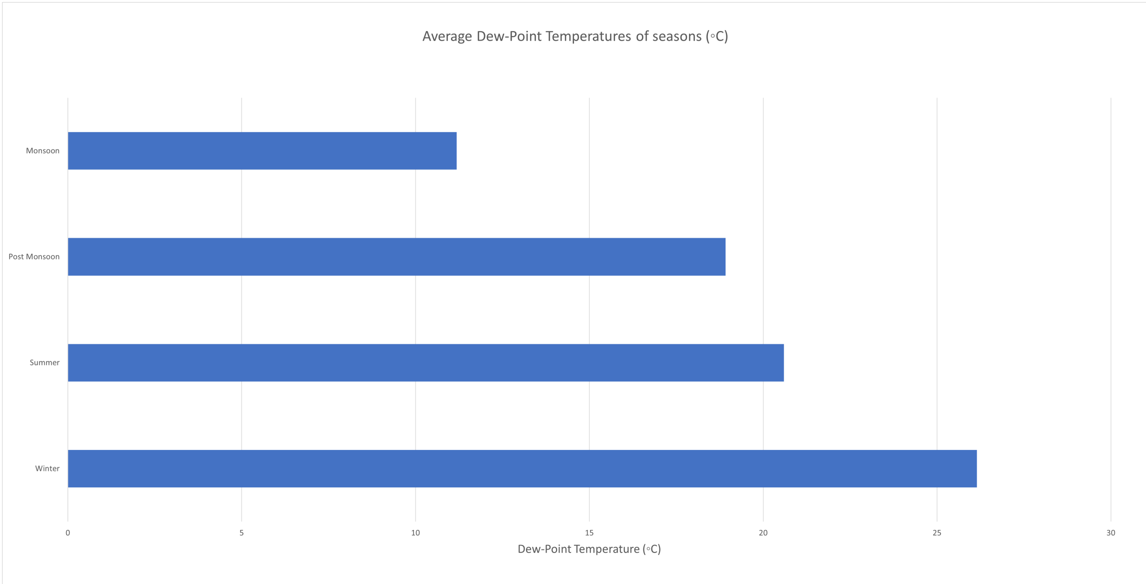

Figure 25: Average Dew-Point Temperatures of the seasons

3.4 The Trend of Rainfall

Rainfall is the most important weather phenomena in the climate of Bangladesh. This meteorological parameter can often be fluctuating depending on multiple variables. So, an in depth overviewing is necessary regarding trend analysis of Rainfall.

In this part of analysis of Rainfall (in mm) , we have analyzed the data set by two major formats : Annual Mean and Annual total Rainfall. The seasonal analysis of Rainfall is also subdivided into these two formats for a better identification of the trends.

Annual Mean Rainfall

The data of Annual Mean Rainfall shows the maximum mean Rainfall was 14.410 mm in year 2017 whereas the minimum was 4.690 mm in year 1999 with the average mean rainfall of 6.745 mm.
The Regression analysis gives us the regression line slope 0.1729 with an intercept of 4.6693 [Figure:26]. Therefore the mean rainfall was 4.6693 mm in 1998 according to regression model. Thus the linear regression line is $y = 0.1729x + 4.6693$ with R^2 value of 0.3227.
Mann-Kendall and Sen's slope test shows that there is an increasing trend in our data set. Also the p-value is 0.028 which is slightly less than α (0.05/5%). The value of this trend is 0.1331 which is the value of Q in Sen's Slope test.

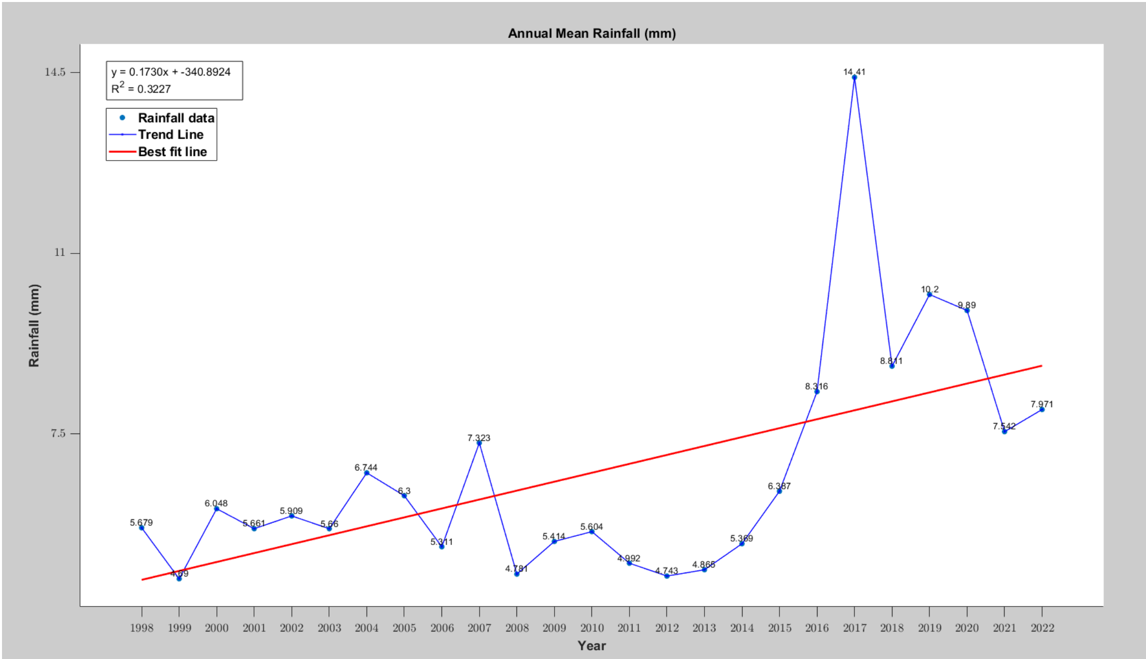

Figure 26: Yearly Mean Rainfall

<table>
<tr><th colspan="6">Annual Mean Rainfall</th></tr>
<tr><th colspan="2">Mann Kendall Trend Test</th><th>Trend</th><th colspan="2">Sen's Slope</th></tr>
<tr><td>S</td><td>94.00</td><td>Increasing</td><td rowspan="3">Q</td><td rowspan="3">0.1331</td></tr>
<tr><td>Var(S)</td><td>1833.33</td><td>Confidence Level</td></tr>
<tr><td>Z(S)</td><td>2.1953</td><td>95%</td></tr>
</table>

Table 20: Mann-Kendall and Sen's Slope of Annual Mean Rainfall

From the Regression plot as well as Mann-Kendall and Sen's Slope test, an indicative upward trend (similar to Yearly total rainfall, unlike that the Sen's slope value is much lower) in annual mean rainfall is observed, hypothesis test detects a positive trend with 95% of confidence level as well. Therefore, there exists a upward trend for yearly mean rainfall.

Annual Total Rainfall

The data of Annual Total Rainfall shows the maximum total Rainfall was 5259.850 mm in year 2017 whereas the minimum was 1712.150 mm in year 1999 with the average mean rainfall of 2463.639 mm.

The Regression analysis gives us the regression line slope 63.158 with an intercept of 1705.734 [Figure:27]. Therefore the mean rainfall was 1705.734 mm in 1998 according to regression model. Thus the linear regression line is $y = 63.158x + 1705.734$ with R^2 value of 0.3227.

Mann-Kendall and Sen's slope test shows that there is an increasing trend in our data set. Also the p-value is 0.028 which is slightly less than α (0.05/5%). The value of this trend is 48.660 which is the value of Q in Sen's Slope test.

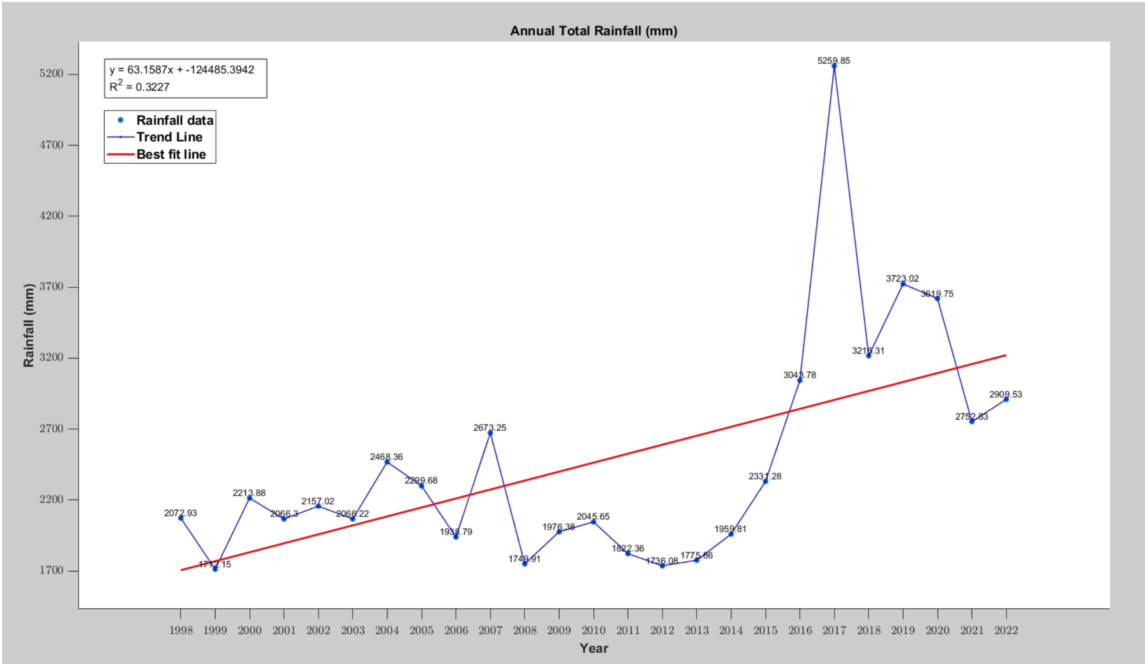

Figure 27: Yearly total Rainfall

Annual Total Rainfall				
Mann Kendall Trend Test		**Trend**	**Sen's Slope**	
S	94.00	Increasing	**Q**	48.660
Var(S)	1833.33	**Confidence Level**		
Z(S)	2.1953	95%		

Table 21: Mann-Kendall and Sen's Slope of Annual Total Rainfall

From the Regression plot as well as Mann-Kendall and Sen's Slope test, an indicative upward trend with a large Q value in annual total rainfall is observed, hypothesis test detects a positive trend with 95% of confidence level as well. Therefore, there exists a upward trend for yearly total rainfall.

Seasonal analysis of Mean Rainfall

Annual mean Rainfall in Summer season

The data of Annual mean Rainfall of Summer shows the maximum mean Rainfall was 16.049 mm in year 2017 whereas the minimum was 3.716 mm in year 2008 with the average mean rainfall of 6.919 mm.
The Regression analysis gives us the regression line slope 0.2249 with an intercept of 4.2194 [Figure:28]. Therefore the mean rainfall was 4.2194 mm in 1998 according to regression model. Thus the linear regression line is $y = 0.2249x + 4.2194$ with R^2 value of 0.2850.
Mann-Kendall and Sen's slope test shows that there is an increasing trend in our data set. Also

the p-value is 0.019 which is slightly less than α (0.05/5%). The value of this trend is 0.1541 which is the value of Q in Sen's Slope test.

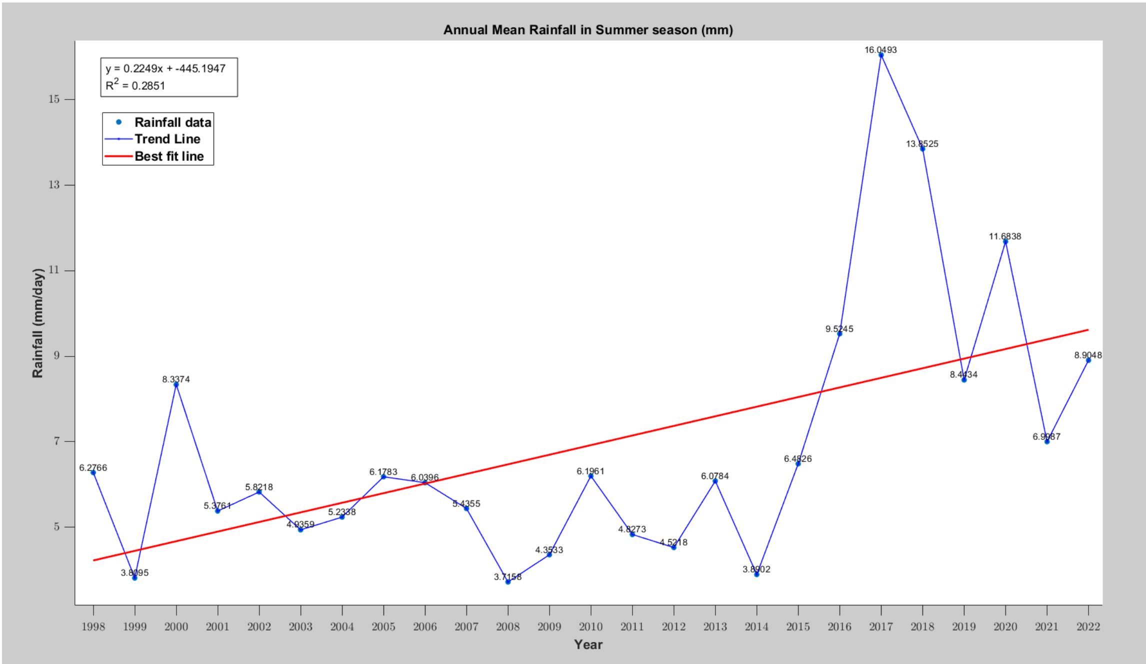

Figure 28: Daily Average Yearly Rainfall in summer season

Annual Mean daily Rainfall in Summer				
Mann Kendall Trend Test		**Trend**	**Sen's Slope**	
S	100.00	Increasing	**Q**	0.1541
Var(S)	1833.33	**Confidence Level**		
Z(S)	2.3354	95%		

Table 22: Mann-Kendall and Sen's Slope of Annual mean daily Rainfall in Summer

From the Regression plot as well as Mann-Kendall and Sen's Slope test, an upward trend in daily annual mean rainfall in summer is observed, hypothesis test detects a positive trend with 95% of confidence level as well. Therefore, there exists a upward trend for yearly mean rainfall in summer.

Annual mean Rainfall in Monsoon

The data of Annual mean Rainfall of Monsoon shows the maximum mean Rainfall was 26.346 mm in year 2017 whereas the minimum was 8.150 mm in year 2013 with the average mean rainfall of 12.786 mm.
The Regression analysis gives us the regression line slope 0.290 with an intercept of 9.3053 [Figure:29]. Therefore the mean rainfall was 9.3053 mm in 1998 according to regression model. Thus the linear regression line is $y = 0.290x + 9.3035$ with R^2 value of 0.2972.
Mann-Kendall and Sen's slope test shows that there is an increasing trend in our data set. Also the p-value is $0.0077 < \alpha$ (0.05/5%). The value of this trend is 0.2185 which is the value of Q in Sen's Slope test.

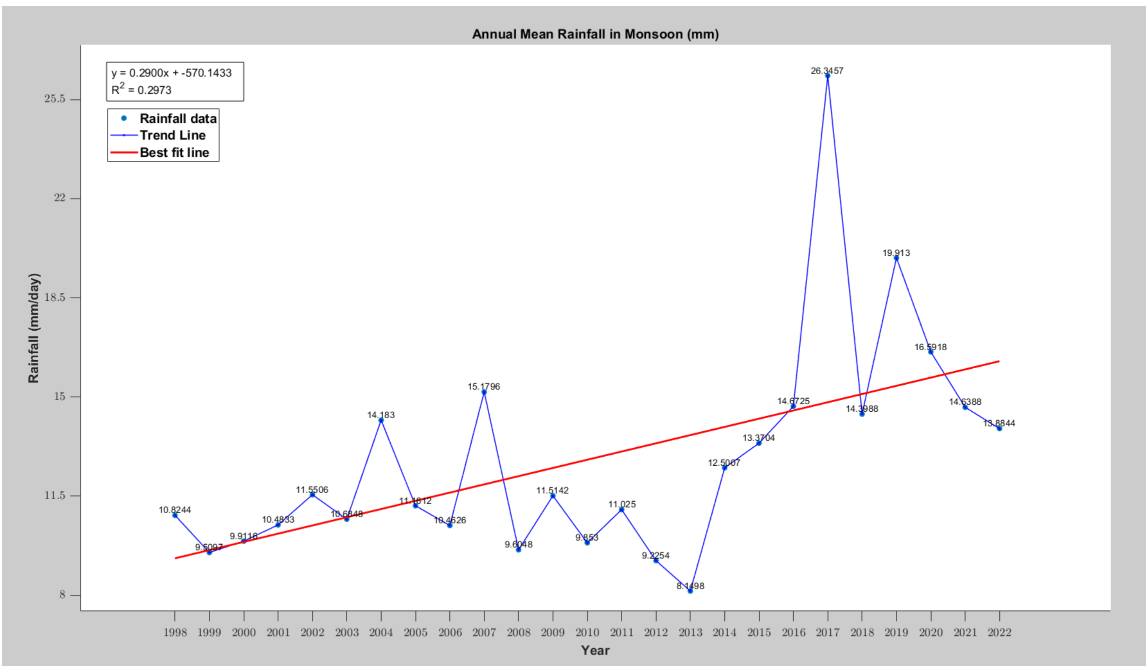

Figure 29: Daily Average Yearly Rainfall in monsoon

<table>
<tr><th colspan="5">Annual Mean daily Rainfall in Monsoon</th></tr>
<tr><th colspan="2">Mann Kendall Trend Test</th><th>Trend</th><th colspan="2">Sen's Slope</th></tr>
<tr><td>S</td><td>114.00</td><td>Increasing</td><td rowspan="3">Q</td><td rowspan="3">0.2185</td></tr>
<tr><td>Var(S)</td><td>1833.33</td><td>Confidence Level</td></tr>
<tr><td>Z(S)</td><td>2.6624</td><td>95%</td></tr>
</table>

Table 23: Mann-Kendall and Sen's Slope of daily Annual mean Rainfall in Monsoon

From the Regression plot as well as Mann-Kendall and Sen's Slope test, an upward trend in daily annual mean rainfall in monsoon is observed, the hypothesis test also detects a positive trend with 95% of confidence level. Therefore, there exists a upward trend for yearly mean rainfall in monsoon.

Annual mean Rainfall in Post-Monsoon

The data of Annual mean Rainfall of Post-Monsoon shows the maximum mean Rainfall was 7.748 mm in year 2020 whereas the minimum was 0.050 mm in year 2011 with the average mean rainfall of 3.572 mm.
The Regression analysis gives us the regression line slope 0.076 with an intercept of 2.6570 [Figure:30]. Therefore the mean rainfall was 2.6570 mm in 1998 according to regression model. Thus the linear regression line is $y = 0.076x + 2.6570$ with R^2 value of 0.0860.
Mann-Kendall and Sen's slope test shows that there is an increasing trend in our data set. Also the p-value is $0.2429 > \alpha$ (0.05/5%). The value of this trend is 0.0718 which is the value of Q in Sen's Slope test.

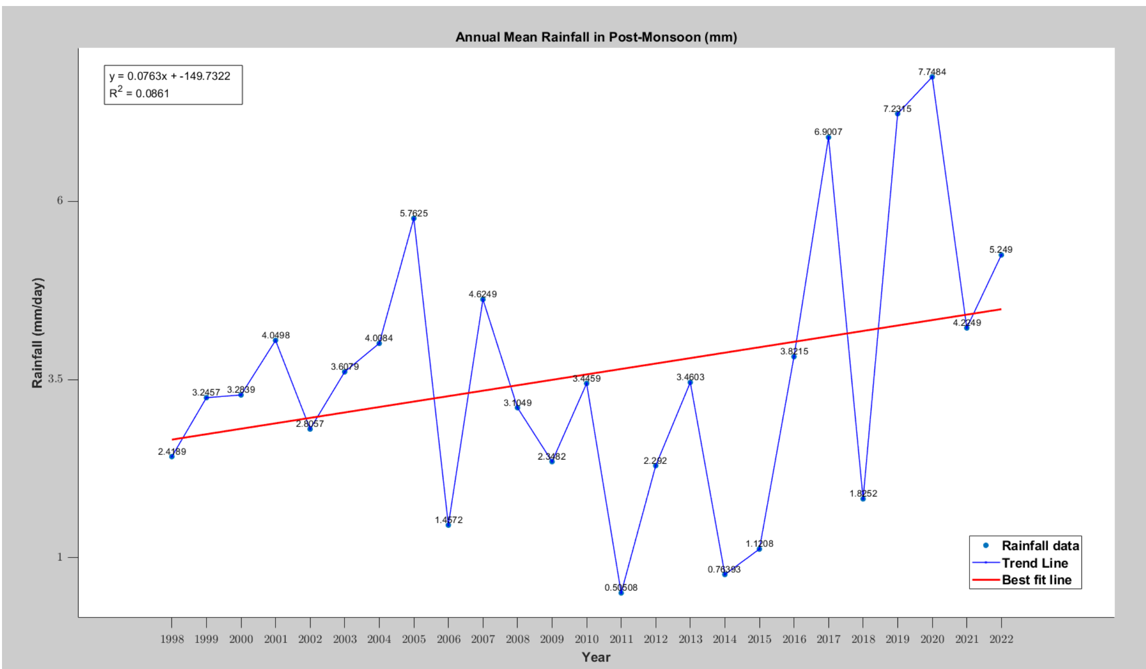

Figure 30: Daily Average Yearly Rainfall in post-monsoon

Annual Mean daily Rainfall in Post-Monsoon				
Mann Kendall Trend Test		Trend	Sen's Slope	
S	50.00	Increasing	**Q**	0.0718
Var(S)	1833.33	**Confidence Level**		
Z(S)	1.1677	95%		

Table 24: Mann-Kendall and Sen's Slope of daily Annual mean Rainfall in Post-Monsoon

From the Regression plot as well as Mann-Kendall and Sen's Slope test, a slight upward trend in daily annual mean rainfall in post-monsoon is observed, but the hypothesis test fails to detect any trend with 95% of confidence level. Therefore, there exists an insignificant trend for yearly mean rainfall in post-monsoon.

Annual mean Rainfall in Winter Season

The data of Annual mean Rainfall of Winter shows the maximum mean Rainfall was 1.647 mm in year 2017 whereas the minimum was 0.027 mm in year 2011 with the average mean rainfall of 0.057 mm.

The Regression analysis gives us the regression line slope 0.026 with an intercept of 0.2238 [Figure:31]. Therefore the mean rainfall was 0.2238 mm in 1998 according to regression model. Thus the linear regression line is $y = 0.026x + 0.2238$ with R^2 value of 0.2277.

Mann-Kendall and Sen's slope test shows that there is an increasing trend in our data set. Also the p-value is 0.00890 which is much less than our assumed α (0.05/5%) value. The value of this trend is 0.0227 which is the value of Q in Sen's Slope test.

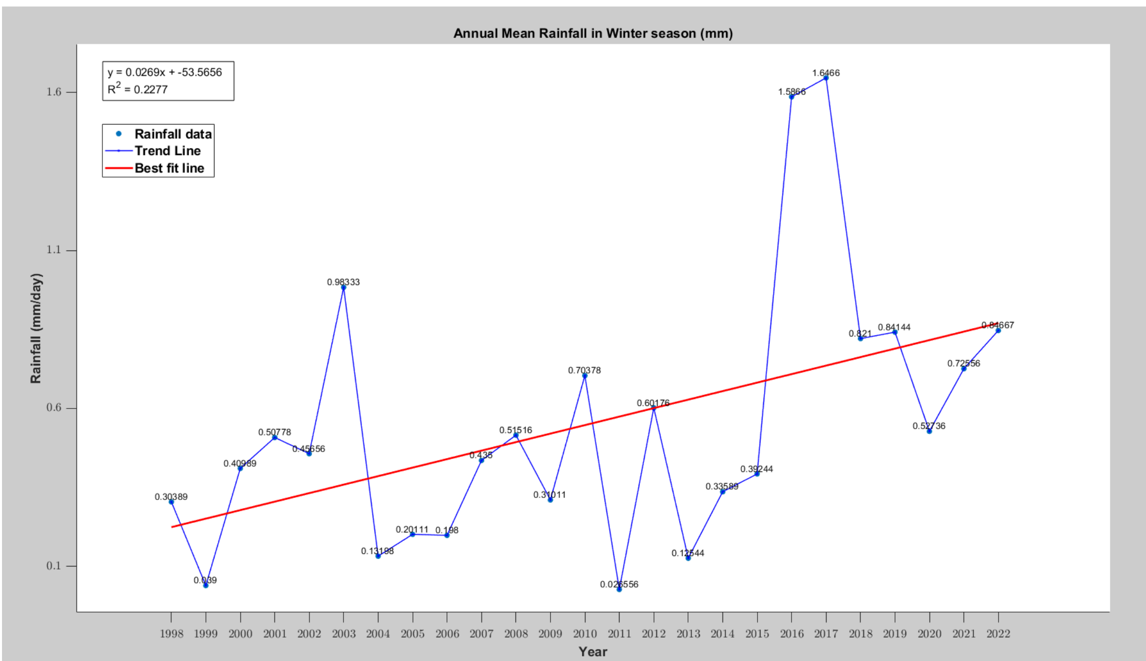

Figure 31: Daily Average Yearly Rainfall in winter season

Annual Mean daily Rainfall in Winter				
Mann Kendall Trend Test		**Trend**	**Sen's Slope**	
S	112.00	Increasing	**Q**	0.0227
Var(S)	1833.33	**Confidence Level**		
Z(S)	2.615	95%		

Table 25: Mann-Kendall and Sen's Slope of daily Annual mean Rainfall in Winter

From the Regression plot as well as Mann-Kendall and Sen's Slope test, an upward trend in daily annual mean rainfall in post-monsoon is observed, the hypothesis test also detects a positive trend with 95% of confidence level. So, there exists an upward trend for yearly mean rainfall in winter.

Seasonal analysis of Total Rainfall

Annual total Rainfall in Summer season

The data of Annual Total Rainfall of Summer shows the maximum total Rainfall was 1476.540 mm in year 2017 whereas the minimum was 341.850 mm in year 2008 with the average mean rainfall of 636.518 mm.
The Regression analysis gives us the regression line slope 20.693 with an intercept of 388.1930 [Figure:32]. Therefore the total rainfall was 388.1930 mm in 1998 according to regression model. Thus the linear regression line is $y = 0.2249x + 4.2194$.

Mann-Kendall and Sen's slope test shows that there is an increasing trend in the data set. (see [Table:26]) Also the p-value is $0.019 < \alpha$ (0.05/5%). The value of this trend *i.e*, the Q value is 14.1842. From the data fit plot we see an upward trend which is detected by the hypothesis test. Thus, there is a positive trend in annual total rainfall in Summer season.

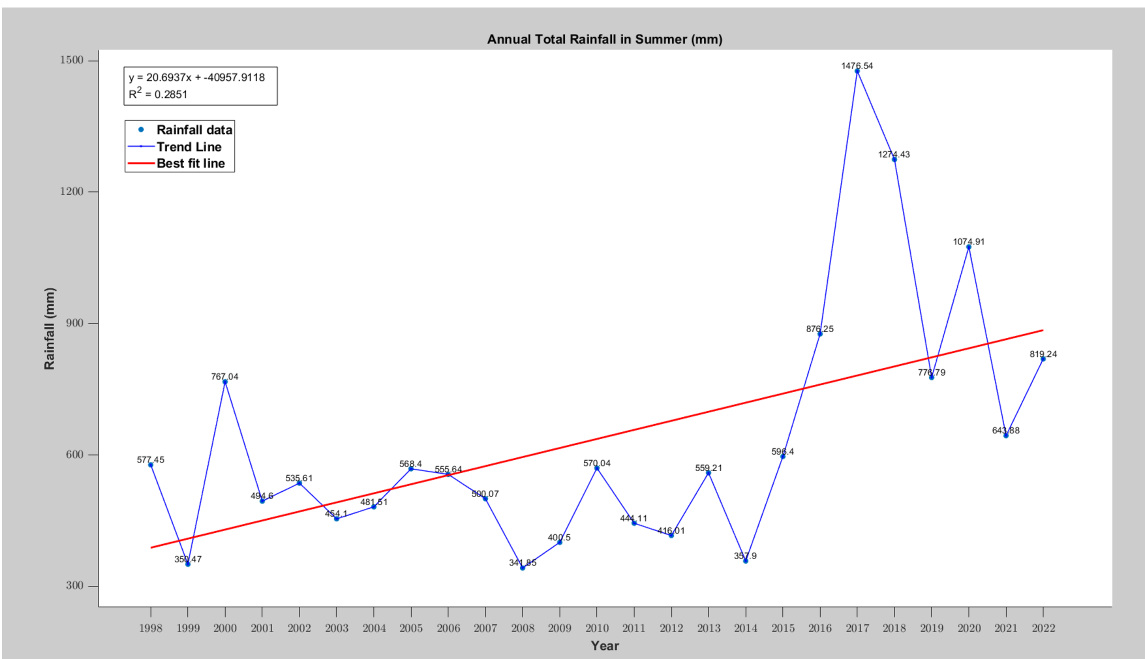

Figure 32: Yearly Total Rainfall in summer season

<table>
<tr><th colspan="6">Annual total Rainfall in Summer</th></tr>
<tr><th colspan="2">Mann Kendall Trend Test</th><th>Trend</th><th colspan="3">Sen's Slope</th></tr>
<tr><td>S</td><td>100.00</td><td>Increasing</td><td rowspan="3">Q</td><td rowspan="3">14.1842</td></tr>
<tr><td>Var(S)</td><td>1833.33</td><td>Confidence Level</td></tr>
<tr><td>Z(S)</td><td>2.3354</td><td>95%</td></tr>
</table>

Table 26: Mann-Kendall and Sen's Slope of Annual Total Rainfall in Summer

Annual total Rainfall in Monsoon

The data of Annual Total Rainfall of Monsoon shows the maximum total Rainfall was 3214.180 mm in year 2017 whereas the minimum was 994.280 mm in year 2013 with the average mean rainfall of 1559.838 mm.
The Regression analysis gives us the regression line slope 35.381 with an intercept of 1135.257 [Figure:33]. Therefore the total rainfall was 1135.257 mm in 1998 according to regression model. Thus the linear regression line is $y = 35.381x + 1135.257$ with R^2 value of 0.2972.

Mann-Kendall and Sen's slope test shows that there is an increasing trend in the data set. (see [Table:27]) Also the p-value is 0.0077 $<< \alpha$ (0.05/5%). The value of this trend *i.e*, the Q value is 26.6578. From the data fit plot we see an upward trend which is detected by the hypothesis test. Thus, there exists a significant positive trend in annual total rainfall in Monsoon.

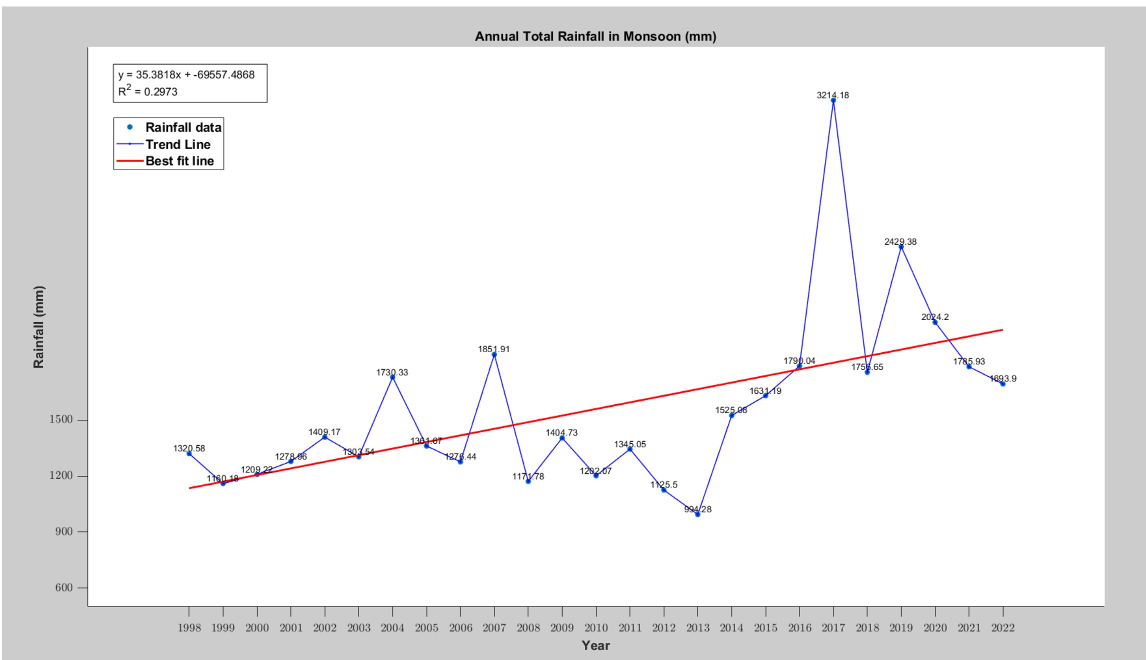

Figure 33: Yearly Total Rainfall in monsoon

<table>
<tr><th colspan="5">Annual total Rainfall in Monsoon</th></tr>
<tr><th colspan="2">Mann Kendall Trend Test</th><th>Trend</th><th colspan="2">Sen's Slope</th></tr>
<tr><td>S</td><td>114.00</td><td>Increasing</td><td rowspan="3">Q</td><td rowspan="3">26.6578</td></tr>
<tr><td>Var(S)</td><td>1833.33</td><td>Confidence Level</td></tr>
<tr><td>Z(S)</td><td>2.6624</td><td>95%</td></tr>
</table>

Table 27: Mann-Kendall and Sen's Slope of Annual Total Rainfall in Monsoon

Annual total Rainfall in Post-Monsoon

The data of Annual Total Rainfall of Post-Monsoon shows the maximum total Rainfall was 472.650 mm in year 2020 whereas the minimum was 30.810 mm in year 2011 with the average mean rainfall of 217.910 mm.
The Regression analysis gives us the regression line slope 4.6525 with an intercept of 162.0793 [Figure:34]. Therefore the total rainfall was 162.0793 mm in 1998 according to regression model. Thus the linear regression line is $y = 4.6525x + 162.0793$ with R^2 value of 0.0860.

Mann-Kendall and Sen's slope test shows that there is an increasing trend in the data set. (see [Table:28]) Also the p-value is $0.2429 > \alpha$ (0.05/5%). The value of this trend *i.e*, the Q value is 4.3808 which is very small. From the data fit plot as well as hypothesis test we see no trend is detected. Thus, a positive trend in annual total rainfall in Post-Monsoon is observed from the regression plot only *i.e*, there is no significant trend.

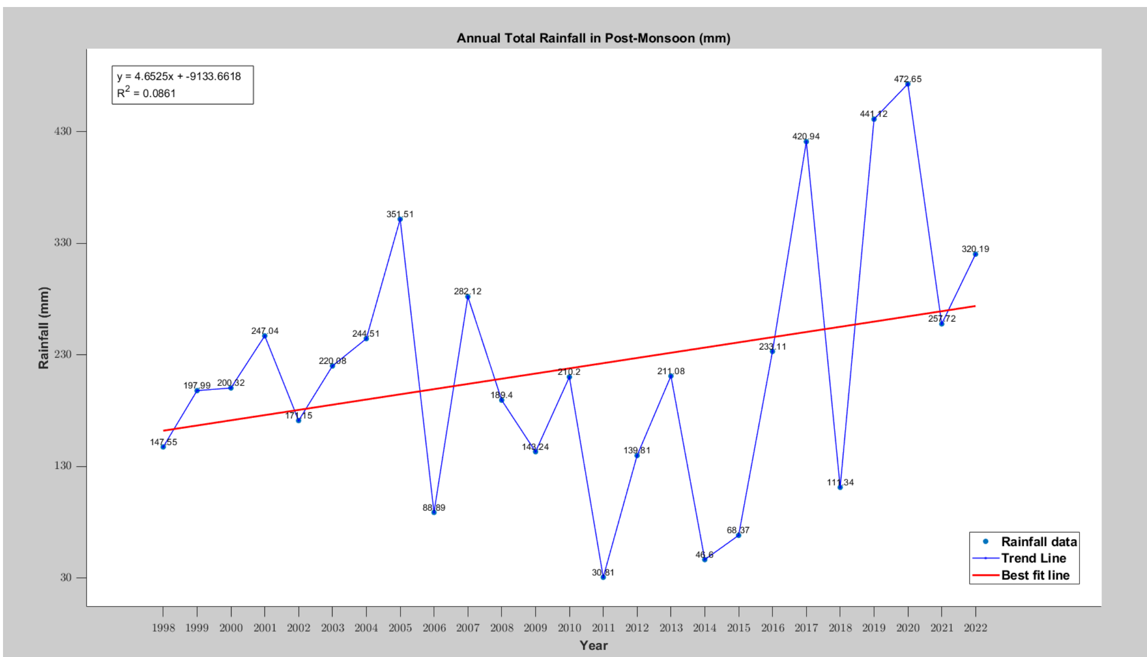

Figure 34: Yearly Total Rainfall in post-monsoon

Annual total Rainfall in Post-Monsoon				
Mann Kendall Trend Test		**Trend**	**Sen's Slope**	
S	50.00	Increasing	**Q**	4.3808
Var(S)	1833.33	**Confidence Level**		
Z(S)	1.1677	95%		

Table 28: Mann-Kendall and Sen's Slope of Annual Total Rainfall in Post-Monsoon

Annual total Rainfall in Winter Season

The data of Annual Total Rainfall of Winter shows the maximum total Rainfall was 148.190 mm in year 2017 whereas the minimum was 2.390 mm in year 2011 with the average mean rainfall of 49.373 mm.
The Regression analysis gives us the regression line slope 2.4307 with an intercept of 20.2038 [Figure:35]. Therefore the total rainfall was 20.2038 mm in 1998 according to regression model. Thus the linear regression line is $y = 2.4307x + 20.2038$ with R^2 value of 0.2272.

Mann-Kendall and Sen's slope test shows that there is an increasing trend in the data set. (see [Table:29]) Also the p-value is $0.0089 << \alpha$ (0.05/5%). The value of this trend *i.e*, the Q value is 2.0340 which is very trivial. From the data fit plot we see a positive trend that also is detected by the hypothesis test. Thus, a positive trend in annual total rainfall in Winter.

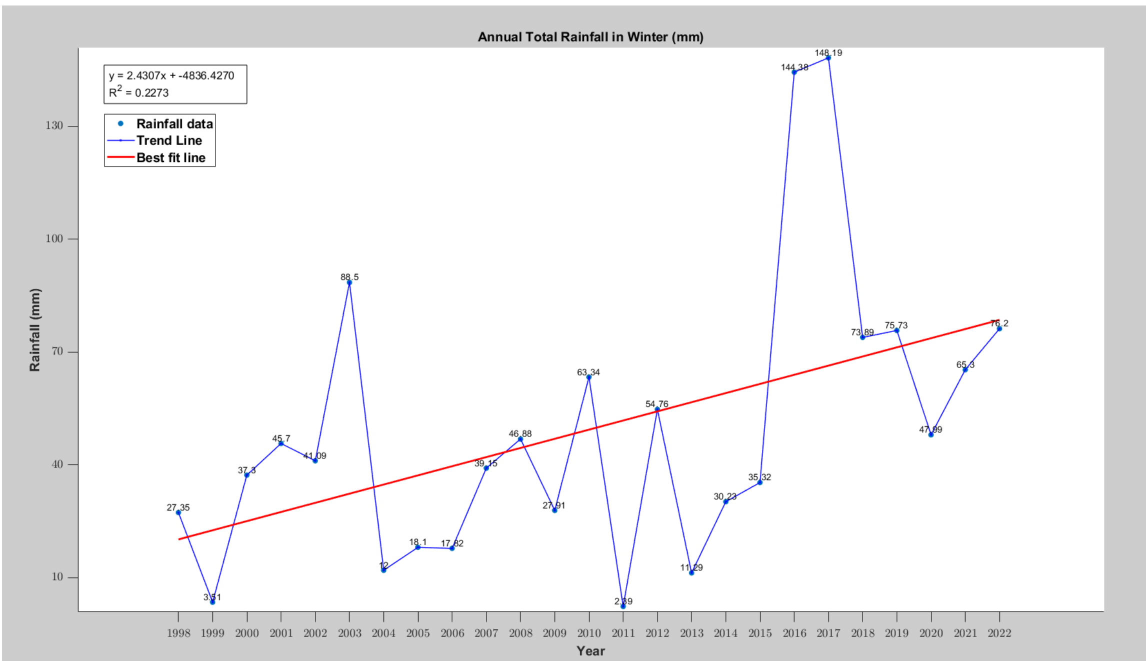

Figure 35: Yearly Total Rainfall in winter

Annual total Rainfall in Winter				
Mann Kendall Trend Test		**Trend**	**Sen's Slope**	
S	112.00	Increasing	**Q**	2.0340
Var(S)	1833.33	**Confidence Level**		
Z(S)	2.6157	95%		

Table 29: Mann-Kendall and Sen's Slope of Annual Total Rainfall in Winter

Annual Rainfall Comparison throughout Seasonal Periods

From the bar diagram shown in [Figure:36] we notice a tremendous amount of rainfall in year 2017. There is considerable annual variability in total rainfall for each season, with some years experiencing extreme monsoon peaks (e.g., 2004, 2010, 2017, and 2019). 2013 is the year with comparatively lowest amount of rainfall in all the seasons combined. Rainfall in the post-monsoon and winter seasons is relatively low compared to summer and monsoon. Post-monsoon rainfall (green) shows minor variations, while winter rainfall (red) remains the lowest and relatively consistent over the years.

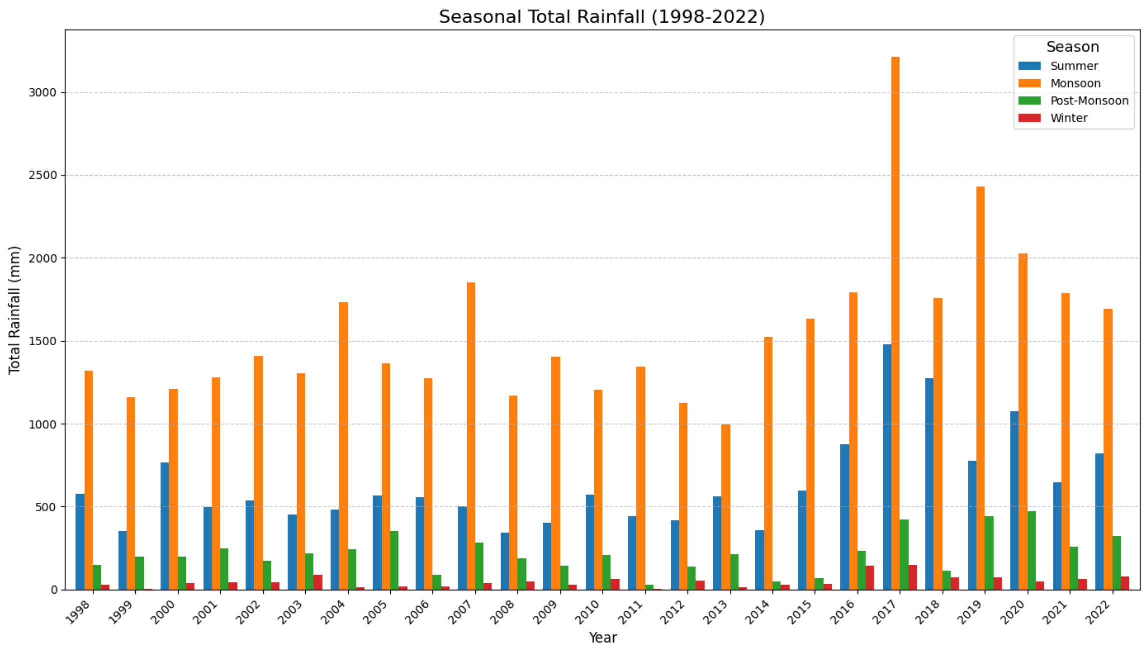

Figure 36: Comparison of Rainfall throughout the seasons

Average Rainfall in Seasons

From the bar plot shown in [Figure:37] it is observed that the Monsoon has highest average Rainfall of 1559.838 mm and the lowest average Rainfall is in Winter with 49.3728 mm.

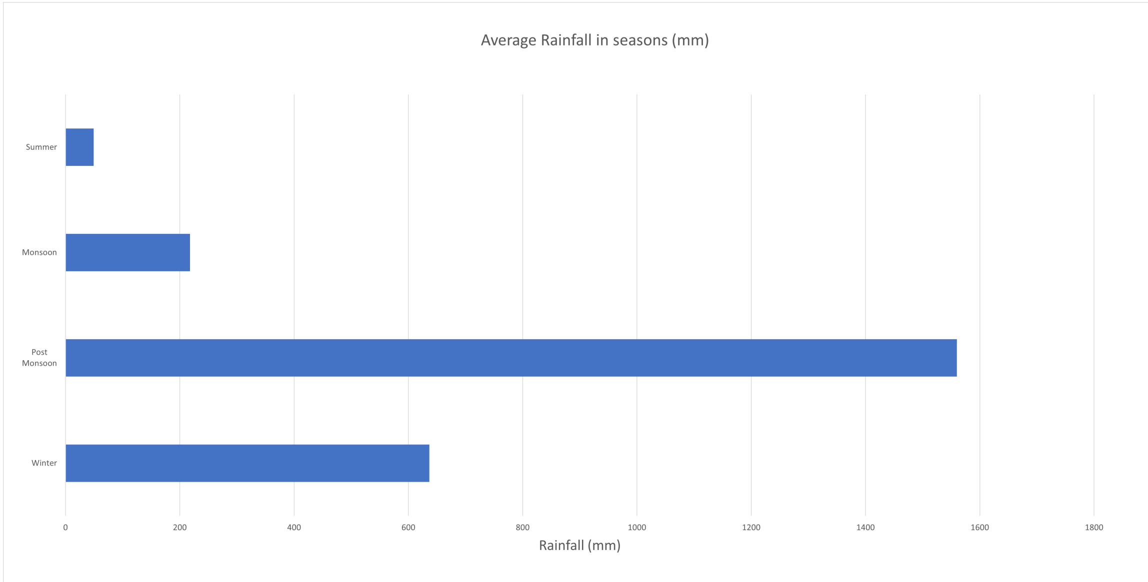

Figure 37: Annual Rainfalls of the seasons

3.5 Correlation between the Four Meteorological Parameters and Summarization

[Figure:38] shows a Correlation Heatmap to visualize the relationship between the parameters. A Strong Negative correlation (-0.62) between Temperature and Relative Humidity is observed, whereas the Relative Humidity holds a Strong Positive correlation (0.83) with the Rainfall.

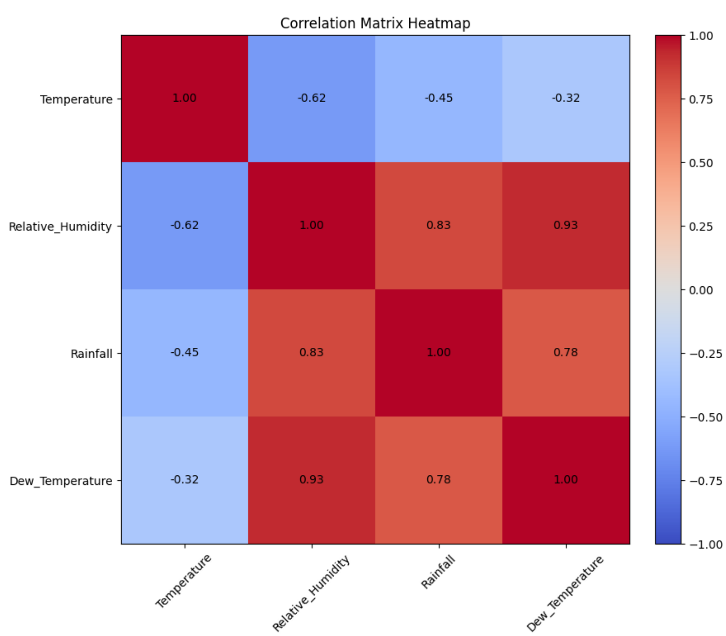

Figure 38: Correlation Heatmap of Meteorological Parameters

Parameters	Temperature	Relative Humidity	Rainfall	Dew Temperature
Temperature	—	−0.62 (Strong negative)	−0.45 (Moderate negative)	−0.32 (Weak negative)
Relative Humidity	−0.62 (Strong negative)	—	0.83 (Strong positive)	0.93 (Very strong positive)
Rainfall	−0.45 (Moderate negative)	0.83 (Strong positive)	—	0.78 (Moderate positive)
Dew Temperature	−0.32 (Weak negative)	0.93 (Very strong positive)	0.78 (Moderate positive)	—

Table 30: Summary of Correlations between Variables

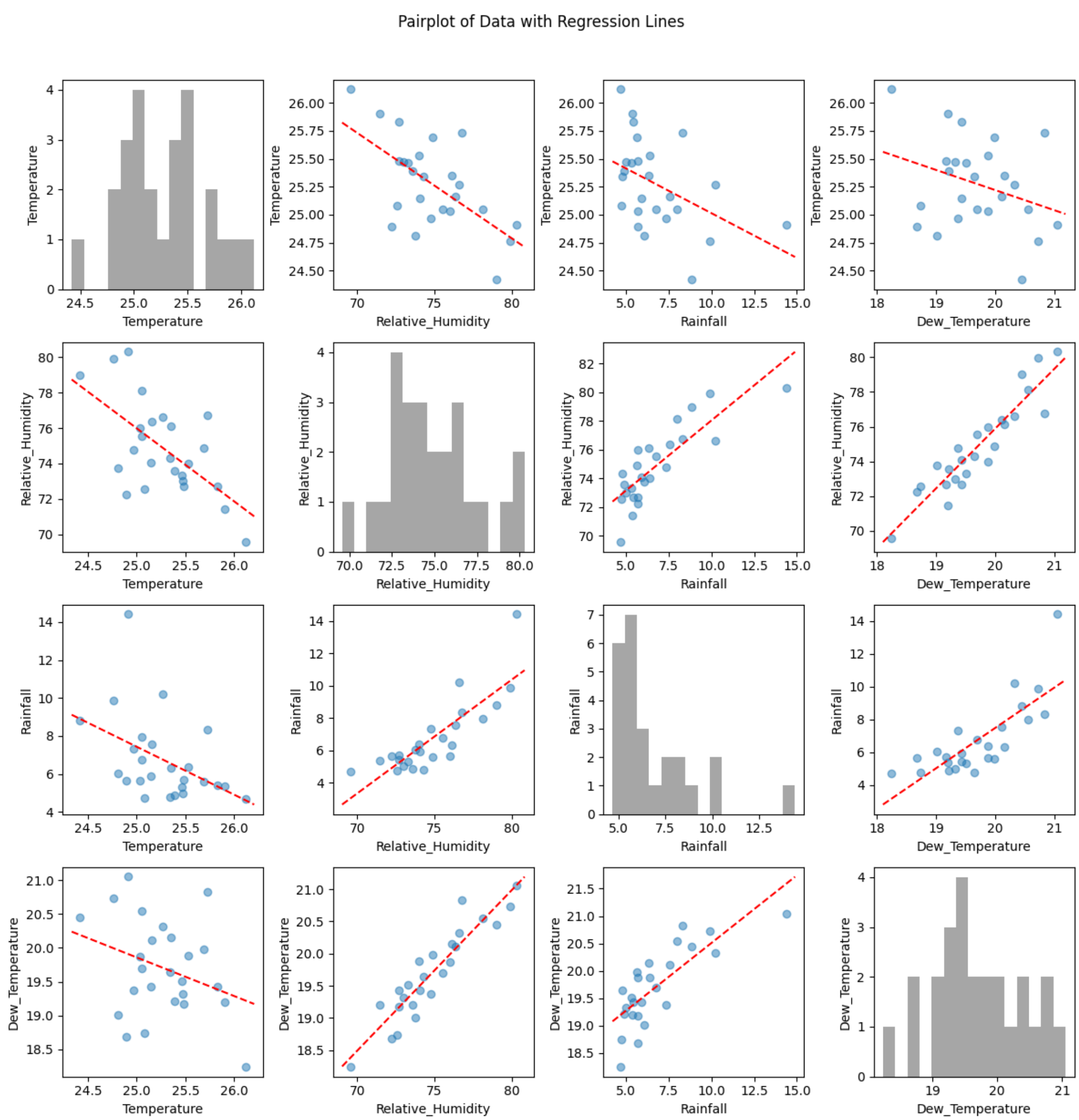

Figure 39: Pairplot of Scattered Data Points

CHAPTER 4

INTERPRETATION

4.1 Summary

The study we conducted offers an in depth inspection of four of the major weather variable of the greater Mymensingh region of Bangladesh naming Temperature, Relative Humidity, Dew-Point Temperature and Rainfall. We have used complete daily data of these four parameters in 25-years timespan (1998-2022), collected from Bangladesh Meteorological Department (BMD) to analyze the trend.

Statistical methods and Machine Learning techniques gives the conclusive result from which a decrease of 0.0053°C is observed in Yearly Mean Temperature along with 0.0696°C and 0.0189°C yearly decline of minimum and maximum temperature, respectively. The overall temperature procures a very weak trend and tends to decrease in terms of annual mean. This main reason behind this unusuality is mostly the drought intensity.
The parameter which has shown the most significant trend in all sort of trend analysis is the Relative Humidity. Starting with Annual Mean Relative Humidity, a 0.2180% of increment results in a major upward trend impact in average Relative Humidity percentage. The Relative Humidity also Shown a fine upward movement, especially in Winter season with an increase of 0.3885% whereas the performance of increment was relatively poorer in Post-Monsoon with 0.0477%.
Followed by Relative Humidity, the average Dew-point Temperature holds the most increment, exceptionally in Winter season (0.100°C). The Annual increase of dew-point temperature is 0.0647°C which is extremely remarkable.
Rainfall illustrates the most complex pattern amongst all the other parameters. Because of having a robust rainfall in year 2017 followed by 2019, the overall trend in all aspects have a upward movement. Annual mean Rainfall increased by 0.1331mm and total Rainfall by 48.660mm. This increment is another reason responsible for the decrease of average annual temperaure in Mymensingh region (correlation co-efficient -0.45).

The Forecasting scenario shows no significant change in the upward trend of rainfall. But the other three parameters shows some heavy change of trend pattern with Temperature having some major fluctuation in decrement. The Relative Humidity and Dew-Point temperature performs almost indentical in terms of Prophet forecasting model used.

4.2 Conclusion

The area of Greater Mymensingh, the north front line is just at the foot of Garo hills of Meghalaya of India, the south this area excludes Gazipur District, the east ends in the rich watery land of Bangladesh as native calls 'Haor', the west ends in the ancient single wood forest (e.g. Muktagacha, Fulbaria and Valuka upazilas) and the Chars of Jamalpur District sided north-west of Mymensingh district (Source : **Wikipedia**). Mymensingh is an agriculturally important but a drought prone district having above average rainfall in Bangladesh. In Mymensingh drought intensity and frequency does not have distinct pattern in the 3 and 6 month lag due to recurrent drought in a short time. Both the intensity and frequency is clear for the period of 24 and 48 month lag representing the hydrological drought.[1]

The annual mean temperature, annual maximum temperature, and annual minimum temperature were all subjected to trend tests for the purposes of temperature analysis. We were able to determine whether there were any noteworthy trends or changes over time in these temperature variables using Statistical Methods with Numerical techniques to handle the data.
We examined seasonal variations and patterns in relative humidity, another important measure of relevance. We investigated the potential alterations in relative humidity levels over time by performing trend tests on the yearly mean relative humidity and seasonal mean relative humidity.
In order to comprehend any variations and changes in the dew-point temperature across the study period, we also focused into the trends in dew-point temperature, both seasonal and annual.
Finally, we looked at rainfall trends in the Mymensingh region. The analysis was managed in yearly total and mean format seperatedly. The aim of our inquisition was to find any notable trends or fluctuations in the amount of rainfall that occurred during the study period. To find so, a total of 10 cases were examined.

To sum up, the thorough trend analysis carried out for this project offers a useful starting point for further studies and policy decisions meant to handle the difficulties brought on by the region's shifting climate. The insights obtained underlines the importance of ongoing research and inhibitory actions to protect the environmental health of Mymensingh.

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