STATISTICAL SYNTHESIS :
EVALUATING ALAPPUZHA’S CLIMATIC ANALYSIS

PROJECT REPORT

Submitted in partial fulfillment of the requirement for the award of degree of

BACHELOR OF SCIENCE IN STATISTICS

Submitted by

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(2021 – 2024)

Under the Guidance of

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DEPARTMENT OF STATISTICS

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CERTIFICATE

This is to certify that the project report entitled **"STATISTICAL SYNTHESIS : EVALUATING ALAPPUZHA'S CLIMATIC ANALYSIS"** is a bonafide record of the project work carried out by **MOHAMMAD NASIQ K N (GTAVSST009), ANEENA MARIYAM P (GTAVSST013), ABHINAV V SUNIL (GTAVSST018), DEVIKA V S (GTAVSST027), SAI GAYATHRI K C (GTAVSST030)** under my supervision and guidance in partial fulfillment of the requirement for the degree of Bachelor of Science in Statistics under the Faculty of Science, University of Calicut, and further that no part of this project has been presented before for any other degree or diploma.

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Place : Thrissur

Date : 12.03.2024

DECLARATION

We, **MOHAMMAD NASIQ K N, ANEENA MARIYAM P, ABHINAV SUNIL, DEVIKA V S, SAI GAYATHRI K C,** hereby declare that this project report entitled **"STATISTICAL SYNTHESIS : EVALUATING ALAPPUZHA'S CLIMATIC ANALYSIS"** is a record of bonafide work done by us in partial fulfillment of the requirement for the degree of B.Sc. Statistics of Calicut University under the guidance of Smt. Flowery Francis, Head of the Department, Sri. C. Achutha Menon Govt. College, Thrissur. We further declare that this project report has not been submitted by us fully or partially for the award of any Degree, Diploma or similar title or recognition.

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CHAPTER 1

INTRODUCTION

Alappuzha District, also known as Alleppey, is a district in the southern state of Kerala, India. It is famous for its intricate network of backwaters, beaches, and lagoons, making it a popular tourist destination. Alappuzha is often referred to as the "Venice of the East" due to its picturesque waterways and houseboat cruises. The district is renowned for its annual Nehru Trophy Boat Race, where long snake boats compete in a thrilling race on the Punnamada Lake. Alappuzha is also known for its coir industry, with many factories producing coir products like mats, rugs, and ropes.The economy of Alappuzha is largely dependent on agriculture, fishing, and tourism. The region is known for its paddy cultivation, with vast stretches of rice fields lining the backwaters. The district is also famous for its traditional art forms like Kathakali and Mohiniyattam, adding to its cultural richness. Over all, Alappuzha District is a vibrant blend of natural beauty, cultural heritage, and economic significance, making it a must-visit destination for travelers seeking a unique experience in Kerala. The district of Alappuzha was formed in 1957. But the place has a long and rich historical as well as the mythological past.

The agricultural practices in Alappuzha district, located in the Indian state of Kerala, are characterized by paddy cultivation, coconut farming, and fishing due to its proximity to the backwaters and coastal areas. The region is known for its Kuttanad region, famously referred to as the "Rice Bowl of Kerala," where paddy fields are cultivated below sea level using innovative farming techniques like 'Pulimuttu' and 'Pokkali' cultivation. Other crops include vegetables, spices, and tropical fruits, while aquaculture is also prominent, with shrimp farming being a significant activity. Traditional farming methods coexist with modern agricultural practices in the region. Furthermore, the integration of traditional and modern farming methods underscores the resilience and adaptability of Alappuzha's agricultural sector. Moving forward, sustainable practices will be crucial to ensuring the continued prosperity of agriculture in Alappuzha district while preserving its unique cultural and environmental heritage.

1.1 Geography

Alappuzha previously known as Alleppey is a district of Kerala and is, basically, a sandy stretch of land criss-crossed by numerous water bodies, rivers, canals and lagoons. The district covers a total area of 546 square meters. The significant existence of a lake in this district called Vembanad which covers an area of 847 square meters where joins six different rivers before stretching towards the coastal line. The west of Alappuzha there is the Laccadive Sea. The abundance of water bodies of both the sea and the fresh water made this town heaven for fishing and enhances the economy. The land of Alappuzha is very fertile especially for ice cultivation. Apart from rice, Coconut is another product hugely cultivate in Alappuzha.

1.2 Temperature:

The temperature in Alappuzha remains warm throughout the year, with relatively small variations between seasons. The average annual temperature ranges from around 25°C to 31°C (77°F to 88°F). The hottest months are typically April and May, with temperatures occasionally reaching above 35°C (95°F), while the coolest months are December and January.

1.3Climate

Rainfall: Alappuzha receives heavy rainfall due to the southwest monsoon, which usually arrives in June and continues until September. The district experiences an average annual rainfall of around 2,900 millimeters
(114 inches), with the peak rainfall occurring during the monsoon season. The monsoon rains are essential for replenishing the backwaters and sustaining the region's lush greenery.

Humidity: Alappuzha experiences high humidity levels throughout the year, ranging from 70% to 90%. The combination of high temperatures and humidity can make the weather feel hot and humid, especially during the summer months.

1.4 Seasons:

- **Summer (March to May)**: Summers in Alappuzha are hot and humid, with temperatures ranging from 30°C to 35°C (86°F to 95°F). The weather is characterized by clear skies and occasional thunderstorms.
- **Monsoon (June to September)**: The monsoon season brings heavy rainfall to Alappuzha, with frequent showers and thunderstorms. The backwaters and rivers swell during this time, creating a picturesque landscape.
- **Post-monsoon (October to November)**: After the monsoon season, Alappuzha experiences a period of transition with decreasing rainfall and cooler temperatures. The weather becomes more pleasant, making it an ideal time for outdoor activities

Overall, Alappuzha experiences a tropical climate with significant rainfall and warm temperatures throughout the year, making it a lush and verdant destination known for its backwaters, beaches, and natural beauty.

1.5 Factors Affecting Temperature

Several factors can affect the temperature of Alappuzha, a city in Kerala, India. Some of these factors include:

1. **Latitude:** Alappuzha is located near the equator, so it experiences warm temperatures throughout the year.

2. **Season:** The temperature in Alappuzha varies with the seasons. Summers (March to May) are hot and humid, with temperatures often exceeding 30°C (86°F). Monsoon season (June to September) brings heavy rainfall and slightly cooler temperatures. Winters (December to February) are mild and pleasant, with temperatures ranging from 22°C to 32°C (72°F to 90°F).

3. **Ocean Influence:** Alappuzha's proximity to the Arabian Sea influences its climate. Sea breezes can moderate temperatures, especially during the hotter months.

4. **Topography:** The city's coastal location and low elevation contribute to its warm and humid climate.

5. **Monsoon Winds:** The southwest monsoon brings heavy rainfall to Alappuzha, which can temporarily lower temperatures.

6. **Urbanization:** Urban areas tend to be warmer than rural areas due to the heat-absorbing properties of buildings and pavement, known as the urban heat island effect.

7. **Vegetation:** The presence of vegetation can also influence temperature, with green spaces and trees providing shade and cooler microclimates.

8. **Cloud Cover:** Cloud cover can impact temperatures by either trapping heat near the surface (warmer nights) or reflecting sunlight (cooler days).

These factors, among others, interact to determine the temperature patterns in Alappuzha throughout the year.

1.6 Factors Affecting Rain-fall

1. Monsoon Winds: Alappuzha experiences both southwest monsoon (June to September) and northeast monsoon (October to November) seasons, which bring the majority of its rainfall. The direction and intensity of these monsoon winds influence the amount of rainfall.

2. Topography: The topography of the region, including its proximity to the Western Ghats and the Arabian Sea, plays a significant role in determining rainfall patterns. The Western Ghats act as a barrier to moisture-laden winds, leading to orographic rainfall on the windward side and creating a rain shadow effect on the leeward side.

3. Ocean Currents: The temperature of the Indian Ocean and the currents flowing in it can influence the amount of moisture carried by winds that reach Alappuzha, impacting rainfall patterns.

4. Local Climate Features: Factors such as sea breeze convergence, land-sea temperature differences, and local atmospheric stability can also affect rainfall distribution within the region.

5. Global Climate Patterns : Large-scale climate phenomena like the El Niño-Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) can have significant impacts on rainfall variability in Alappuzha and the broader Indian subcontinent.

6. Urbanization and Land Use Changes: Urbanization and land use changes can alter local microclimates, affecting rainfall patterns through changes in surface albedo, heat absorption, and land cover.

7. Climate Change: Long-term changes in global climate patterns, including increases in greenhouse gas emissions, can lead to shifts in rainfall patterns and intensities in Alappuzha and beyond.

1.7 Objectives of the Study

- To estimate trend in rainfall and temperature of Alappuzha District
- To develop seasonal indices for rainfall maximum and minimum temperature.
- To compare seasonal indices in different time period

CHAPTER 2

REVIEW OF LITERATURE

A literature review is the synthesis of the available literature regarding the research topic. This chapter provides an overview of previous research on knowledge sharing and intranets. It introduces the framework for the case study that comprises the main focus of the research described in this thesis. The main purpose of the literature review many be purely descriptive, as in an annotated bibliography or it may provide a critical assessment of the literature in a particular filed, starting where the weakness and gaps are contrasting the view of particular authors or raising questions.

Bhanua et al. (2021) conducted a comprehensive analysis of monsoon rainfall data spanning from 1991 to 2014 in the Cherthala region of Alappuzha district, Kerala. They developed a mathematical model employing singular value decomposition and multiple linear regression to forecast rainfall. Their findings indicate a higher frequency of drought years compared to wet years in the Cherthala region. Notably, they observed significant variability in September rainfall, with a recorded increasing trend of 7.64 mm/year. The most accurate model for rainfall prediction in the region incorporated ocean heat content (OHC) in the specified range, yielding a root mean square error (RMSE) of 1.03 mm/day.

- Archana Nair et al. (2014) analyzed rainfall patterns across northern and southern regions of Kerala, highlighting significant variations on different timescales. They identified shifting means and variabilities during seasons, with a notable decreasing trend observed over the last century, particularly in January, July, and November. This decline is attributed to global anomalies stemming from anthropogenic activities such as greenhouse gas emissions, urbanization, deforestation, and transportation-related pollutants.
- A trend analysis conducted by KSCSTE highlighted decreasing southwest monsoon season rainfall trends across most districts of Kerala from 1901 to 2021.

However, Idukki district exhibited an increasing trend, albeit not statistically significant. Similar decreasing trends were observed during the northeast monsoon season, except in Kasaragod district, where a non-significant increasing trend was noted.

- Guhathakurta et al. (2020) observed varying rainfall patterns across Kerala, with maximum rainy days occurring in northern and central regions during the southwest monsoon season. Conversely, southern Kerala experiences fewer rainy days. They also noted district-wise variations in heavy rainfall occurrences, with implications for water resource management and agricultural practices.
- Preenu et al. (2017) investigated the variability of monsoon onset dates over Kerala spanning 150 years. They found wide variations in the onset dates, with significant inter-annual and decadal-scale variability linked to sea surface temperature (SST) anomalies, reminiscent of El Niño/La Niña phenomena. Additionally, they identified two episodes of active convection associated with monsoon onset over the Indian Ocean, with a notable decadal-scale variability correlated with SST gradients across the equator.
- Krishnakumar et al. examined temporal variations in monthly, seasonal, and annual rainfall over Kerala from 1871 to 2005. Their analysis revealed a significant decrease in southwest monsoon rainfall but an increase during the post-monsoon season. While rainfall during winter and summer showed insignificant trends, June and July exhibited decreasing trends, raising concerns about water availability for hydel power generation and agricultural activities.
- The report compiled by the Department of Mining and Geology (2016) indicates an average annual rainfall of 2965.4 mm in Alappuzha district, with the southwest monsoon contributing approximately 60.3% of the total annual rainfall. These findings underscore the significance of understanding rainfall patterns for effective resource management and environmental planning in the region.
- The newspaper article by K. A. Shaji dated 23 August 2023 highlights the situation of drought-like conditions across all 14 districts of Kerala due to the complete failure of the southwest monsoon. Special emphasis is placed on the impact of decreased rainfall on the Kuttanad region, renowned as Kerala’s rice bowl, situated

in the Alappuzha district. The intrusion of saline water into rice fields has severely hampered cultivation, exacerbating the crisis. Additionally, the article underscores the acute drinking water scarcity in Kuttanad, a region below sea level and surrounded by expansive backwaters, where residents must rely on government boats to procure safe drinking water. This situation reflects a concerning trend of declining rainfall levels in the Alappuzha district (K. A. Shaji,2023)

- Furthermore, a comprehensive analysis spanning 141 years of rainfall data reveals substantial interannual variability. The research identifies a biennial oscillation wherein years with notably above-normal rainfall are succeeded by those with significantly below-normal rainfall, and vice versa. This oscillation is closely linked to changes in ocean surface temperatures in the tropical Indian and west Pacific oceans. Additionally, examination of monthly rainfall trends indicates a significant increasing trend during February, March, October, and November. Conversely, there is a noticeable decrease in the contribution of June and July rainfall to the annual total, from 28% to 22.4% and 23% to 18.4%, respectively, over the 141-year period. Moreover, a distinct north-south variability in monthly and seasonal rainfall patterns is observed, with north Kerala receiving more rainfall during the southwest monsoon season compared to the post-monsoon season (V.K. Mini, et al. 2016)
- In another study by Praveen B, et al (2020) focusing on the analysis of rainfall trends and forecasting in India using non-parametric and machine learning approaches, conducted from 1905 to 2015, similar trends were identified. These findings underscore the necessity for formulating management plans to ensure sustainable development of water resource-based sectors and the environment. It is suggested that researchers in other countries undertake similar investigations to gather historical, present, and future data essential for devising effective strategies across various fields such as hydrology and climatology. This collaborative approach is crucial for addressing the challenges posed by changing rainfall patterns and mitigating their adverse impacts.

CHAPTER 3

METHODOLOGY

Daily weather data for Alappuzha district from 1969 to 2022 were collected from Indian Meteorological Department (IMD). The variables included in the study are maximum temperature, minimum temperature, and rainfall. The daily data were converted in to monthly data using pivot table in MS Excel. Time series plots, trend estimation and seasonal indices were worked out for this data. Other statistical analysis, including paired t-test were conducted for comparing data in different time periods to check whether there is any shift in temperature or rainfall. This was conducted using the PAST software. Data were tested for stationary using autocorrelation in the Gretl software.

3.1 Collection of data

Data collection is the process of gathering information or data from different sources for analysis and interpretation. It is a crucial step in research, decision-making, and problem-solving across various domains. The collection of data can be conducted through various methods, including primary and secondary data collection. In this project, we will be utilizing secondary data as our primary method of data collection.

3.2 Time Series

Time series analysis is a statistical method used to analyze and interpret data sequentially ordered in time. It involves studying patterns, trends, and dependencies within the data to make predictions or draw insights. In a time series, each observation is associated with a specific timestamp, such as daily stock prices, monthly sales data, or hourly temperature readings.

The general equation of a time series model can be represented as follows: $Y_t = f(t) + e_t$

3.3.1 Components of Time series

Time series data is a sequence of data points recorded or collected at regular time intervals. It is a type of data that tracks the evolution of a variable over time, such as sales, stock prices, temperature, etc. The regular time intervals can be daily, weekly, monthly, quarterly, or annually, and the data is often represented as a line graph or time-series plot. Time series data is commonly used in fields such as economics, finance, weather forecasting, and operations management, among others, to analyze trends, and patterns, and to make predictions or forecasts.

Time series data typically consists of four main components: trend, seasonality, cyclicality, and irregularity.

1. **Trend:** The trend component represents the long-term pattern or direction in the data. It indicates whether the data is increasing, decreasing, or fluctuating around a certain level over time. Trends can be linear, non-linear, or even absent. Identifying and modeling the trend helps understand the underlying behavior of the time series.
2. **Seasonality:** Seasonality refers to the repetitive patterns or cycles that occur at fixed intervals within a time series. These patterns can be daily, weekly, monthly, quarterly, or yearly, depending on the nature of the data. Seasonality is often driven by external factors like weather, holidays, or other calendar events. Properly capturing and modeling seasonality is crucial for making accurate forecasts and predictions.
3. **Cyclicality:** Cyclicality represents the fluctuations or oscillations in the data that are not fixed to a specific time period. Unlike seasonality, cycles in time series data do not repeat at regular intervals. Cycles may have varying lengths and can be influenced by economic or business cycles, global trends, or other external

factors. Identifying cyclical patterns helps understand longer-term variations in the data.

4. **Irregularity or Residuals:** Irregularity, sometimes referred to as residuals or noise, refers to the random or unpredictable fluctuations in the time series that are not accounted for by trend, seasonality, and cyclicality. These residuals can arise from various factors like measurement errors, random shocks, or other unexplained influences. Analyzing the residuals helps assess the quality and appropriateness of a time series model.

3.2.2 Decomposition Of Time Series

The formulas for decomposing a time series depend on the specific decomposition method used. Two common methods are additive and multiplicative decomposition.

1. Additive Decomposition:

$$y(t) = \text{Trend}(t) + \text{Seasonal}(t) + \text{Residual}(t)$$

2. Multiplicative Decomposition:

$$y(t) = \text{Trend}(t) \times \text{Seasonal}(t) \times \text{Residual}(t)$$

Where the components have the same meanings as in the additive decomposition. These formulas are used to model the observed time series data as a combination of its constituent components, allowing for analysis and forecasting various techniques, such as moving averages or seasonal indices, can be used to estimate these components from the observed data.

3.3 Methods to Estimate Trend

Estimating trends in time series data is an important task in various fields, such as economics, finance, climate science, and social sciences. Several methods can be employed to estimate trends in time series data.

1. **Graphical method:** The graphical method to estimate trends in a time series is known as the line graph method. This method involves plotting the data points of the time series on a graph and visually analyzing the pattern of the plotted points.
2. **Least Square Method:** The least squares method is a statistical technique used to estimate trends in time series data by fitting a linear regression model to the observed values. It seeks to find the line that minimizes the sum of squared differences between the predicted values and the actual values in the time series.
3. **Moving average method:** The moving average method is a widely used technique in time series analysis that helps in smoothing out the noise or random fluctuations in the data and identifying the underlying trends or patterns. It calculates the average of a specified number of consecutive data points, known as the window or period, and uses this average as the smoothed value for a particular point in the time series.
4. **Seasonal indices method:** The seasonal indices method is a technique used to estimate periodicities within a year in the time series data by accounting for seasonal patterns and variations. It involves calculating seasonal indices that represent the relative strength or magnitude of the seasonal component at different time points within a seasonal cycle.

3.4 Diagrams and Charts

Diagrams and charts are visual representations of data or information, used to communicate complex ideas or relationships in a clear and concise manner. They are essential tools in various fields, including business, engineering, science, and academia.

1. Bar Diagram

A bar diagram is a type of diagram that uses rectangular bars to represent and compare different categories or data points. It is a visual representation of data that is commonly used to display and analyze categorical or discrete data. In a bar diagram, each category or data point is represented by a separate bar, with the length or height of the bar corresponding to the value or quantity it represents. The bars are typically plotted along an axis, such as the x-axis for horizontal bar diagrams or the y-axis for vertical bar charts.

2. Line Chart

A line chart is a simple and commonly used graphical representation of time series data. It plots the data points on a graph with time on the x-axis and the observed values on the y-axis. By looking at the overall shape of the line, you can get an idea of the direction and magnitude of the trend.

3.5 TESTING AND ESTIMATION

1.t-Test

1.A t-test is a statistical hypothesis test used to determine if there is a significant difference between the means of two groups or populations. It is commonly used when comparing the means of two samples to determine if the observed difference is statistically significant, or if it can be attributed to random chance.

A paired t-test is a statistical test used to compare the means of two related or paired samples. It is often employed when the data is collected from the same subjects or objects at two different time points, under different conditions, or in a specific before-after scenario.

2.R-squared (coefficient of determination)

R-Squared (R^2) is a statistical measure used to determine the proportion of variance in dependent variable that can be predicted or explained by an independent variable. It ranges from 0 to 1, where 1 indicates a perfect fit and 0 indicates no linear relationship between the variables.

3.Autocorrelation

Autocorrelation is the correlation between observations that are n time periods apart. It measures the relationship between lagged values of a time series, just as Pearson's correlation measures the depree of a linear relationship between two variables. Autocorrelation function is used in econometric modeling to determine stationarity and seasonality.

CHAPTER 4

DATA ANALYSIS AND INTERPRETATION

Results

Maximum Temperature

Daily data for Alappuzha for the period from 1969 to 2022 were collected from IMD and converted it to monthly data and used for the analysis. Month wise Trends and Seasonal components were estimated for the variables Max Temperature, Minimum Temperature and Rainfall for the period.

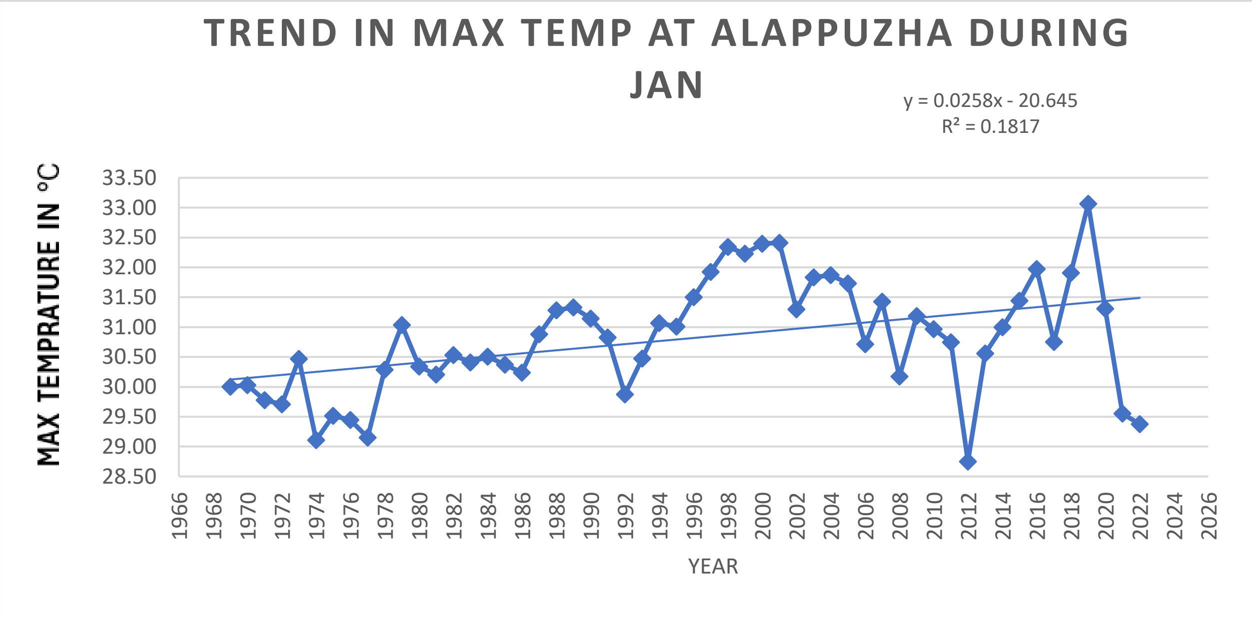

Fig 4.1. Trends in Maximum Temperature at Alappuzha during January

From Fig 4.1, it could be observed that there is an upward trend in Maximum Temperature during January. The regression model estimated is $Y_t = 0.0258x_t - 20.645$ with an R^2 of 0.1817, indicating 18.1% of variation that can be explained by this model. From the trend it could be observed that the coming January season will be hot as given in the forecasts in Table 4.4.

Table 4.1. Predicted Maximum Temperature at Alappuzha in JANUARY for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in January	31.57	31.60	31.63	31.65	31.68	31.70	31.73

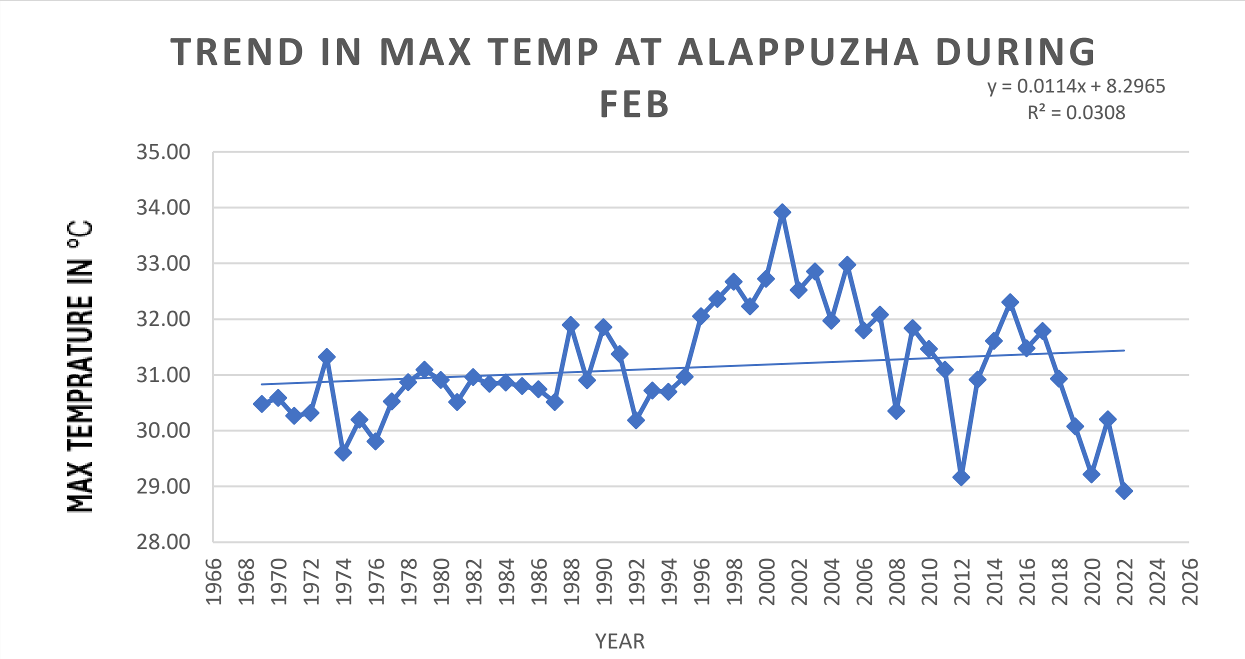

Fig 4.2. Trends in Maximum Temperature at Alappuzha during February

From Fig 4.2, it could be observed that there is an upward trend in Maximum Temperature during February. The regression model estimated is Y_t= 0.0114 X_t + 8.29655 with an R^2 of 0.0308, indicating 30% of variation that can be explained by this model. From the trend it could be observed that the coming February season will be hot as given in the forecasts in Table 4.2.

Table 4.2. Predicted Maximum Temperature at Alappuzha in February for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in February	31.37	31.38	31.39	31.40	31.42	31.43	31.44

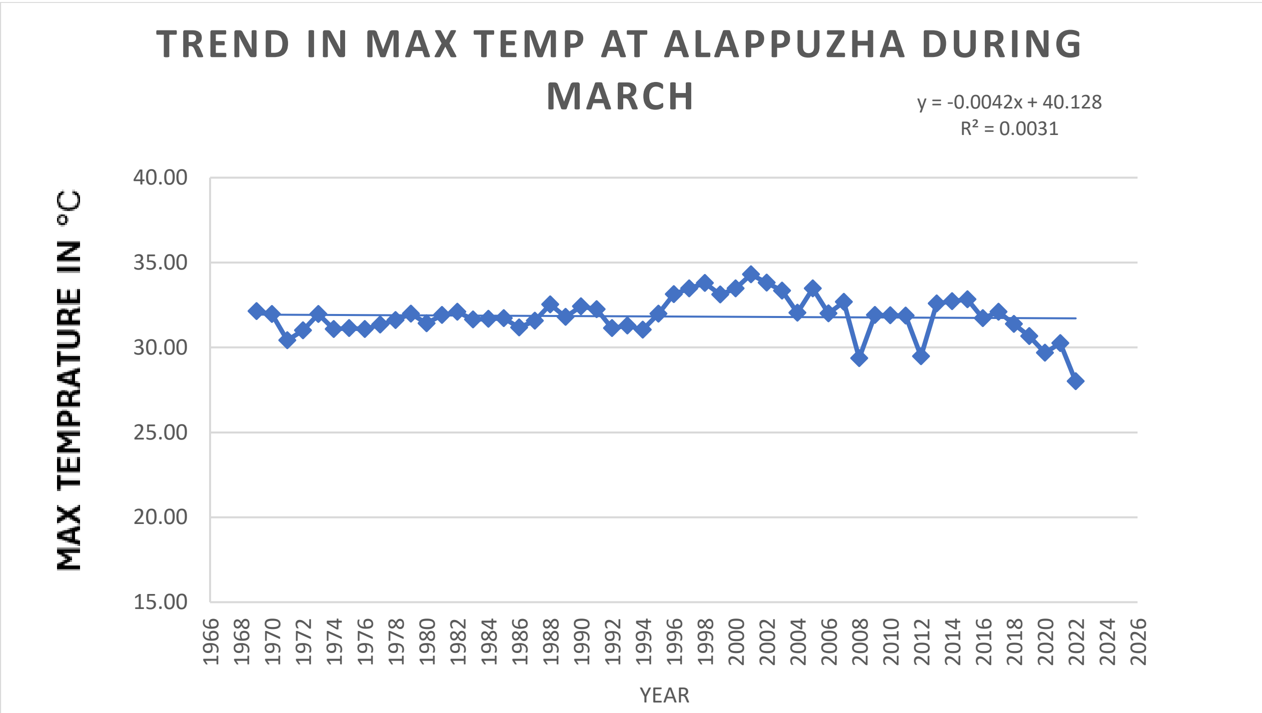

Fig 4.3. Trends in Maximum Temperature at Alappuzha during March

From Fig 4.3, it could be observed that there is an downward trend in Maximum Temperature during March. The regression model estimated is Y_t = -0.0042 X_t + 40.128 with an R^2 of 0.0031, indicating 0.31 % of variation that can be explained by this model. From the trend it could be observed that the coming March season will be hot as given in the forecasts in Table 4.3.

Table 4.3. Predicted Maximum Temperature at Alappuzha in March for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in March	31.63	31.62	31.62	31.61	31.61	31.6 1	32.60

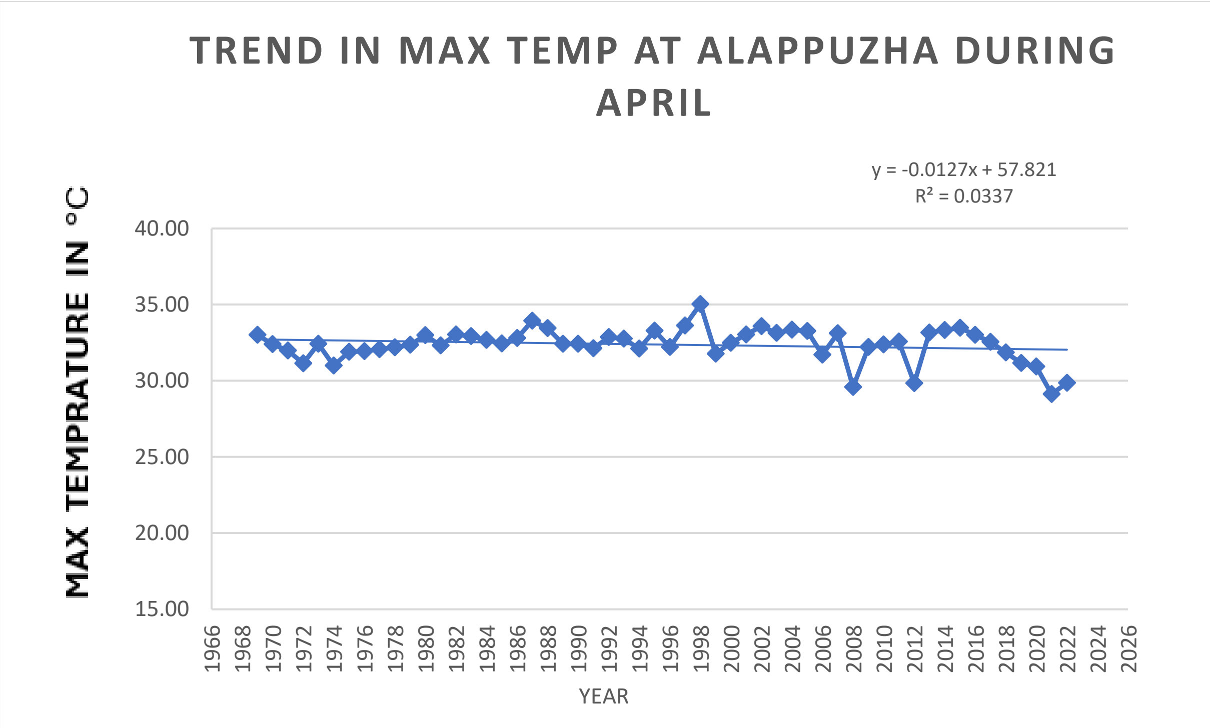

Fig 4.4. Trends in Maximum Temperature at Alappuzha during April

From Fig 4.4, it could be observed that there is a downward trend in Maximum Temperature during April. The regression model estimated is Y_t = = -0.0127 X_t + 57.821 with an R^2 of 0.0337, indicating 33 % of variation that can be explained by this model. From the trend it could be observed that the coming April season will be hot as given in the forecasts in Table 4.4.

Table 4.4. Predicted Maximum Temperature at Alappuzha in April for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in April	31.98	31.97	31.95	31.94	31.93	31.9 2	31.91

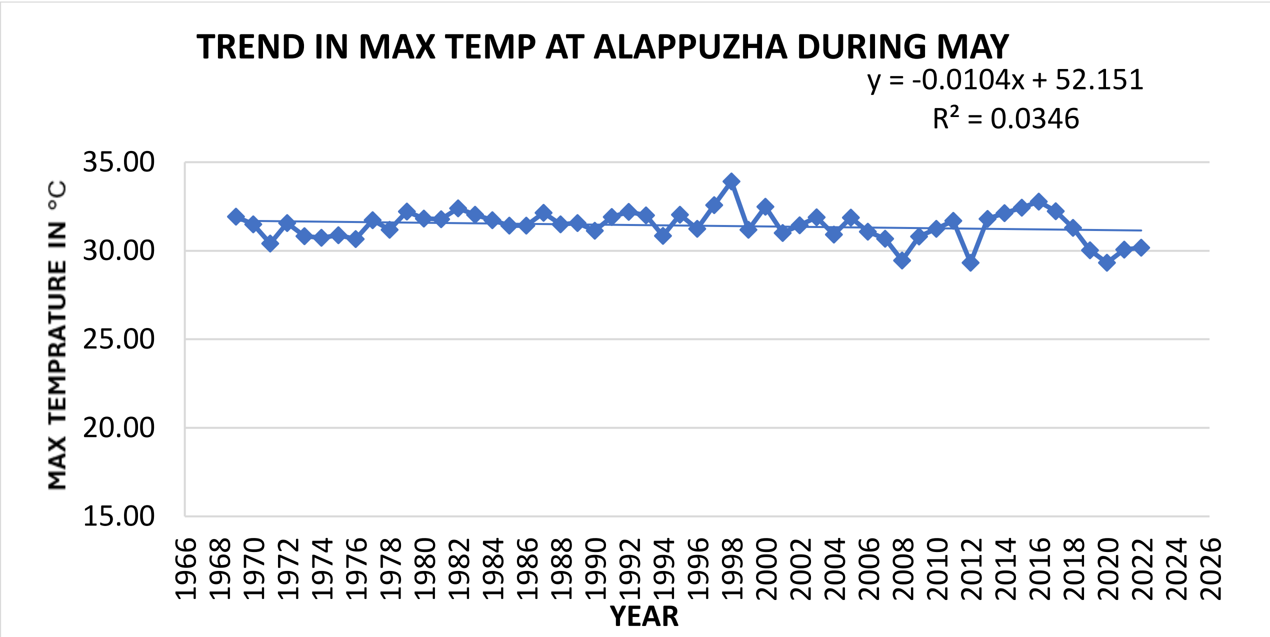

Fig 4.5. Trends in Maximum Temperature at Alappuzha during May

From Fig 4.5, it could be observed that there is a downward trend in Maximum Temperature during May. The regression model estimated is $Y_t = -0.0104x + 52.151$ with an R^2 of 0.0346, indicating 34 % of variation that can be explained by this model. From the trend it could be observed that the coming May season will be hot as given in the forecasts in Table 4.5.

Table 4.5. Predicted Maximum Temperature at Alappuzha in May for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in May	31.15	31.14	31.13	31.12	31.11	31.10	31.09

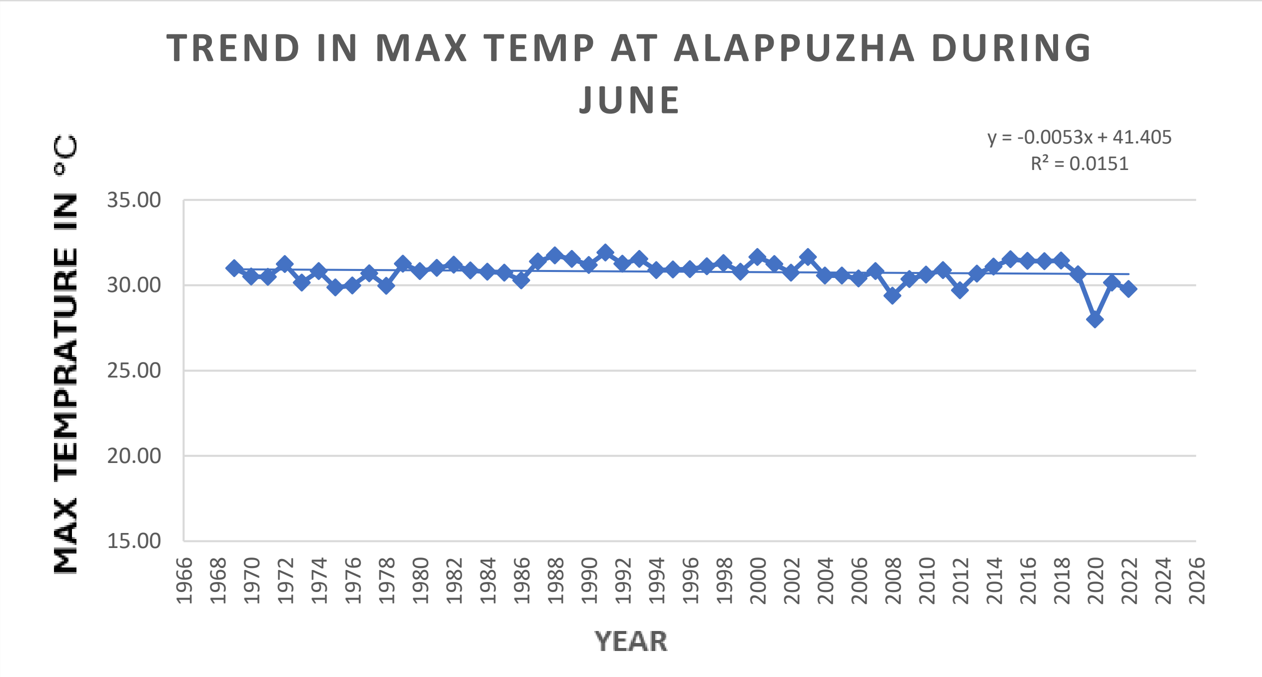

Fig 4.6. Trends in Maximum Temperature at Alappuzha during June

From Fig 4.6, it could be observed that there is a downward trend in Maximum Temperature during June. The regression model estimated is $Y_t = -0.0053 X_t + 41.405$ with an R^2 of 0.0151, indicating 0.15 % of variation that can be explained by this model. From the trend it could be observed that the coming June season will be hot as given in the forecasts in Table 4.6.

Table 4.6. Predicted Maximum Temperature at Alappuzha in June for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in June	30.56	31.55	30.54	30.54	30.53	30.52	30.51

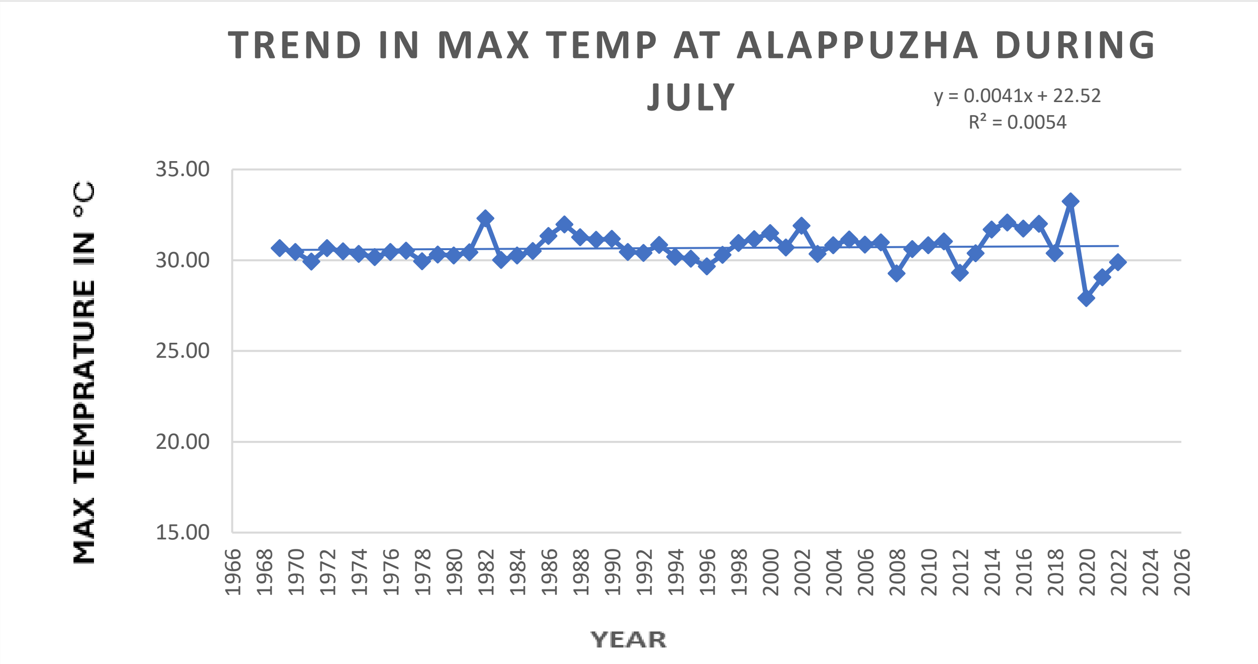

Fig 4.7. Trends in Maximum Temperature at Alappuzha during July

From Fig 4.7, it could be observed that there is an upward trend in Maximum Temperature during July. The regression model estimated is $Y_t = 0.0041\ X_t + 22.52$ with an R^2 of 0.0054, indicating 0.54 % of variation that can be explained by this model. From the trend it could be observed that the coming July season will be hot as given in the forecasts in Table 4.7.

Table 4.7. Predicted Maximum Temperature at Alappuzha in July for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in July	30.66	30.66	30.65	30.65	30.65	30.6 5	30.65

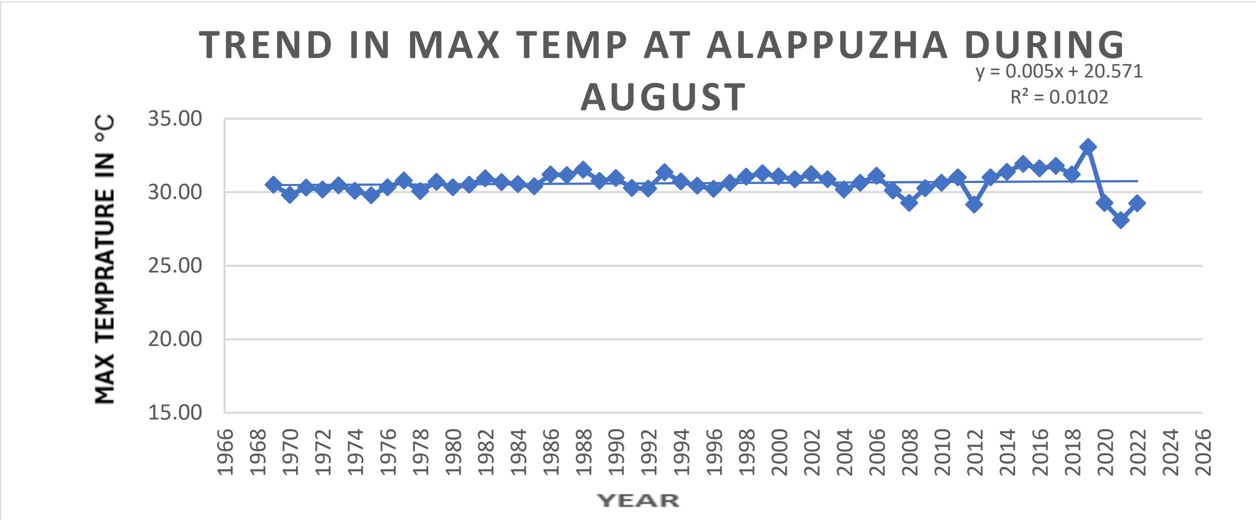

Fig 4.8. Trends in Maximum Temperature at Alappuzha during August

From Fig 4.8, it could be observed that there is an upward trend in Maximum Temperature during August. The regression model estimated is $Y_t = 0.005 X_t + 20.571$ with an R^2 of 0.0102, indicating 0.12% of variation that can be explained by this model. From the trend it could be observed that the coming August season will be hot as given in the forecasts in Table 4.8.

Table 4.8. Predicted Maximum Temperature at Alappuzha in August for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in August	40.60	40.60	40.61	40.61	40.62	40.6 2	40.63

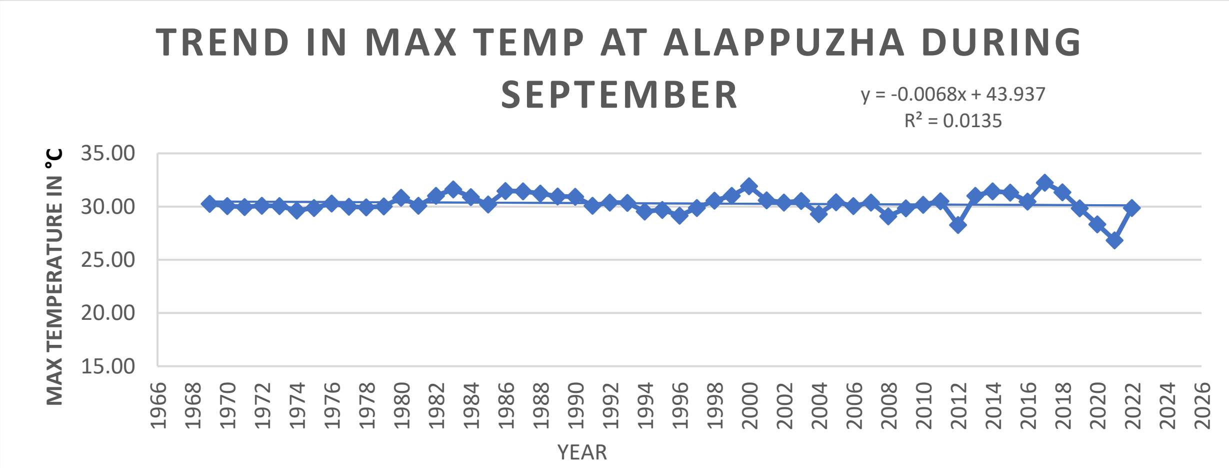

Fig 4.9. Trends in Maximum Temperature at Alappuzha during September

From Fig 4.9, it could be observed that there is a downward trend in Maximum Temperature during September. The regression model estimated is $Y_t = -0.0061 X_t + 30.44$

with an R^2 of 0.0111, indicating 1.11 % of variation that can be explained by this model. From the trend it could be observed that the coming September season will be hot as given in the forecasts in Table 4.9.

Table 4.9. Predicted Maximum Temperature at Alappuzha in September for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in September	16.72	16.71	16.71	16.70	16.69	16.69	16.68

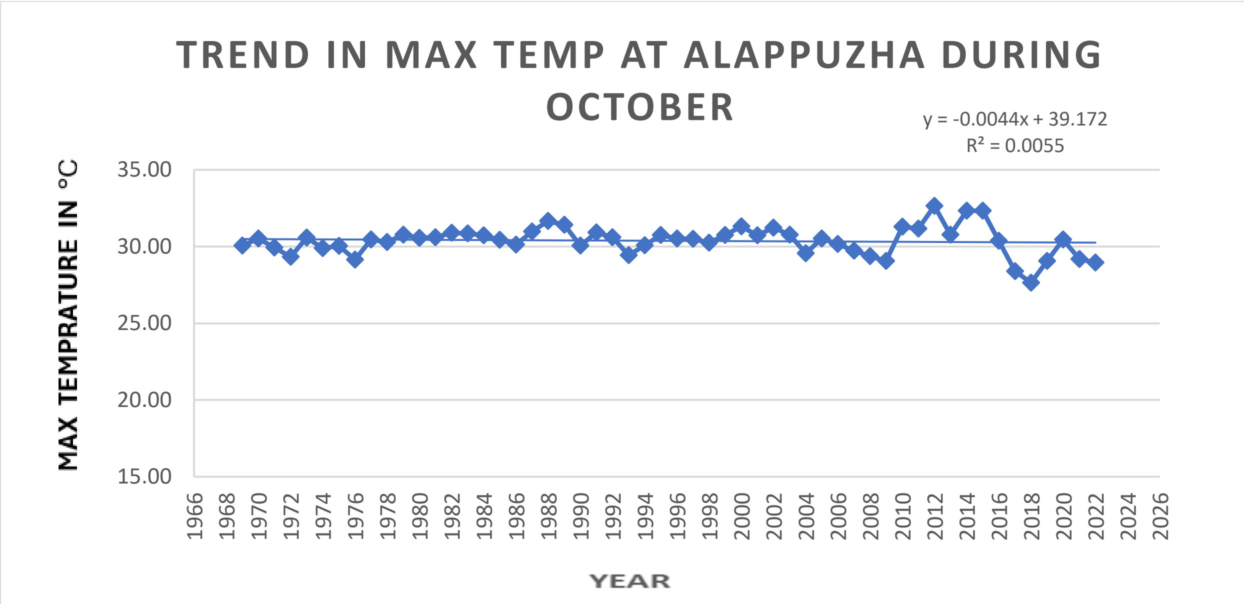

Fig 4.10. Trends in Maximum Temperature at Alappuzha during October

From Fig 4.10, it could be observed that there is an downward trend in Maximum Temperature during October. The regression model estimated is Y_t =-0.0044 X_t +39.172 with an R^2 of 0.0055, indicating 0.55 % of variation that can be explained by this model. From the trend it could be observed that the coming October season will be hot as given in the forecasts in Table 4.10.

Table 4.10. Predicted Maximum Temperature at Alappuzha in October for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in October	30.52	30.52	30.52	30.53	30.53	30.53	30.53

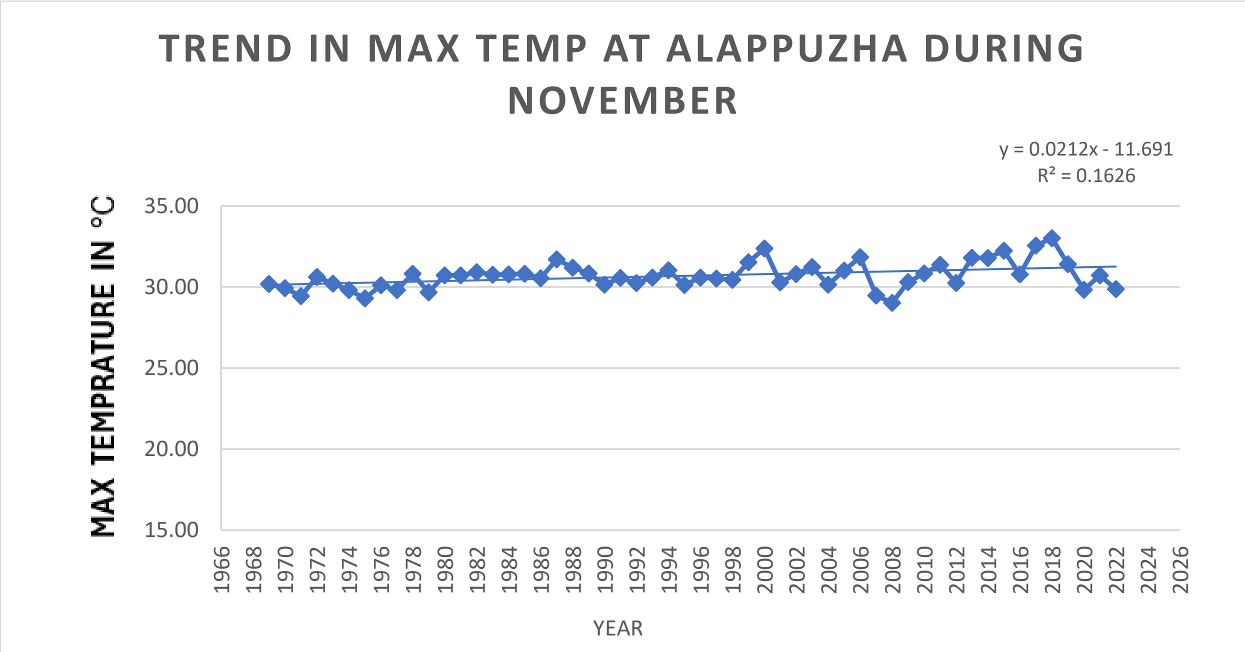

Fig 4.11. Trends in Maximum Temperature at Alappuzha during November

From Fig 4.11, it could be observed that there is an upward trend in Maximum Temperature during November. The regression model estimated is $Y_t = 0.0212 X_t - 11.691$ with an R^2 of 0.1626, indicating 16 % of variation that can be explained by this model. From the trend it could be observed that the coming November season will be hot as given in the forecasts in Table 4.11.

Table 4.11. Predicted Maximum Temperature at Alappuzha in November for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in November	31.37	31.39	31.41	31.44	31.46	31.49	31.51

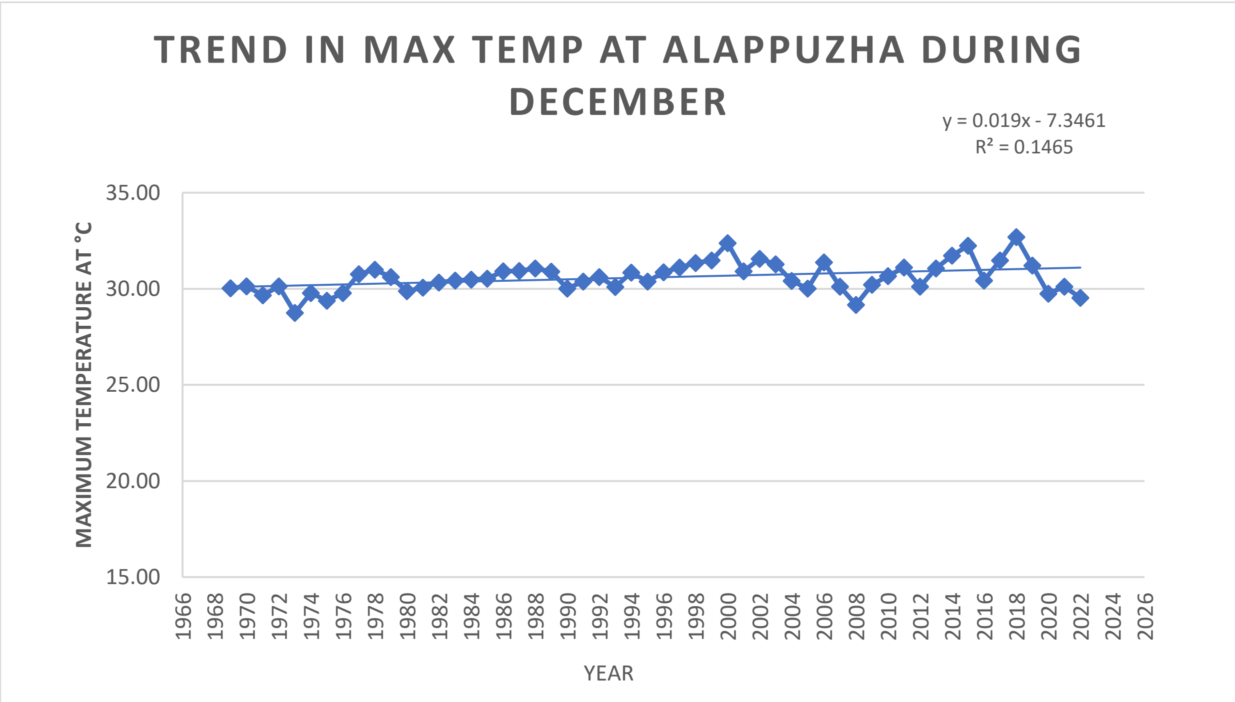

Fig 4.12. Trends in Maximum Temperature at Alappuzha during December

From Fig 4.12, it could be observed that there is an upward trend in Maximum Temperature during December. The regression model estimated is $Y_t = 0.019 X_t - 7.3461$ with an R^2 of 0.1465, indicating 14% of variation that can be explained by this model. From the trend it could be observed that the coming December season will be hot as given in the forecasts in Table 4.12.

Table 4.12. Predicted Maximum Temperature at Alappuzha in December for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in December	31.32	31.34	31.36	31.38	31.40	31.43	31.45

Minimum Temperature

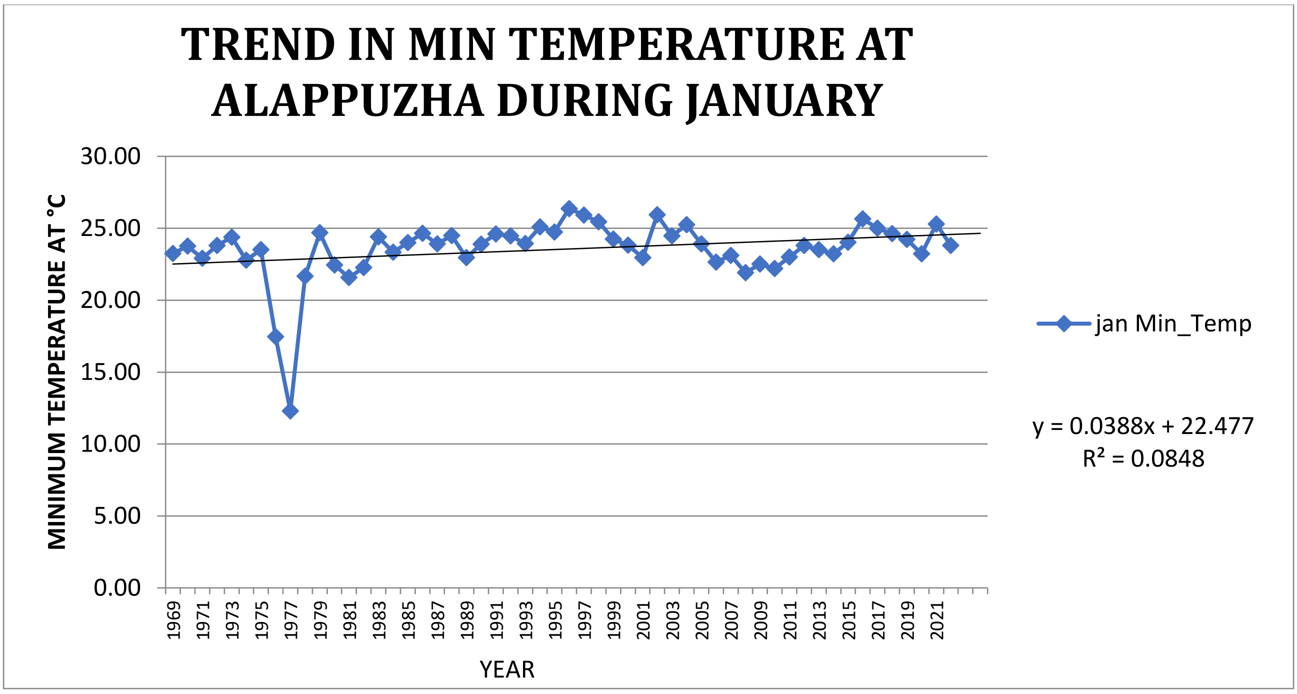

Fig 4.13. Trends in Minimum Temperature at Alappuzha during January

From Fig 4.13, it could be observed that there is an upward trend in Minimum Temperature during January. The regression model estimated is $Y_t = 0.0388\ X_t + 22.477$with an R^2 of 0.0848 indicating 8.48 % of variation that can be explained by this model. From the trend it could be observed that the coming January season will be hot as given in the forecasts in Table 4.13.

Table 4.13. Predicted M Temperature at Alappuzha in JANUARY for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in January	24.65	24.69	24.73	24.77	24.81	24.84	24.88

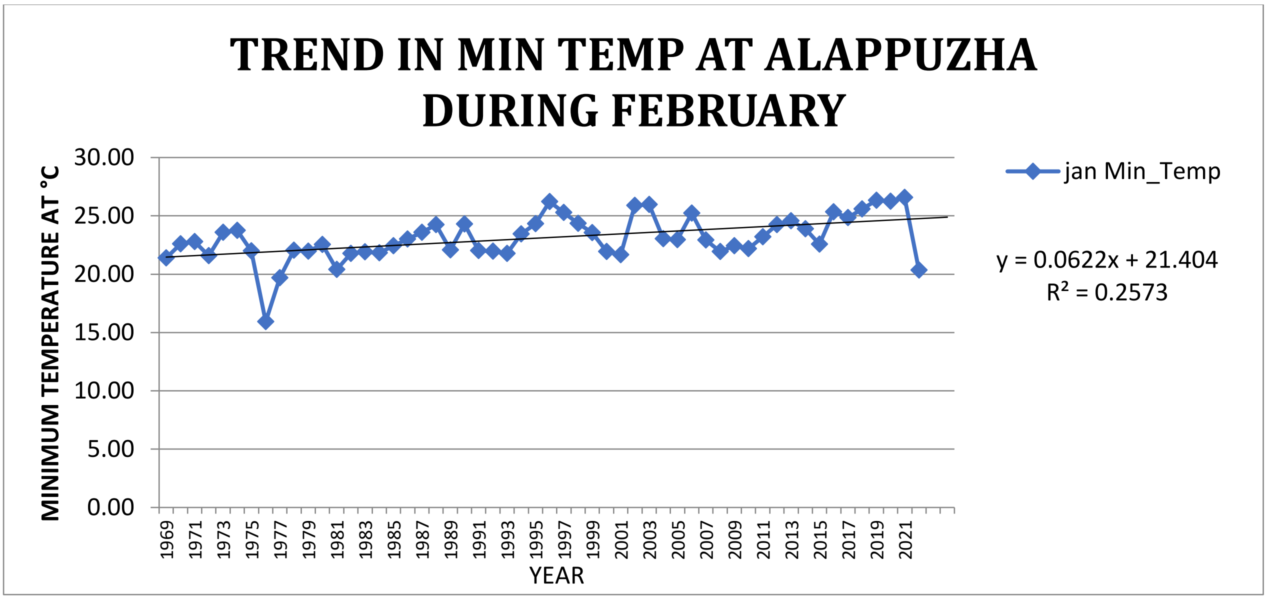

Fig 4.14. Trends in Minimum Temperature at Alappuzha during February

From Fig 4.14, it could be observed that there is an upward trend in Minimum Temperature during February. The regression model estimated is Y_t= 0.0622 X_t + 21.404 with an R^2 of 0.2573, indicating 25.73% of variation that can be explained by this model. From the trend it could be observed that the coming February season will be hot as given in the forecasts in Table 4.14.

Table 4.14. Predicted Minimum Temperature at Alappuzha in February for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in February	25.6034	25.707	25.8112	25.9151	26.019	26.1229	26.2268

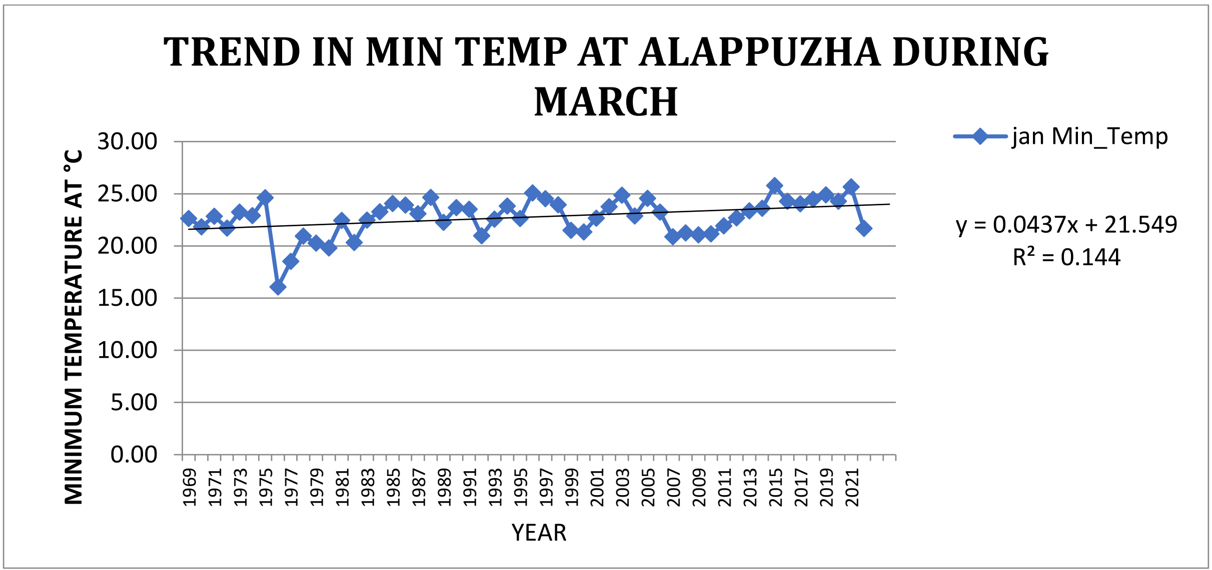

Fig 4.15. Trends in Minimum Temperature at Alappuzha during March

From Fig 4.15, it could be observed that there is an upward trend in Minimum Temperature during March. The regression model estimated is $Y_t = 0.0437\ X_t + 21.549$ with an R^2 of 0.144indicating 14.4% of variation that can be explained by this model. From the trend it could be observed that the coming March season will be hot as given in the forecasts in Table 4.15.

Table 4.15. Predicted Minimum Temperature at Alappuzha in March for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in March	24.7316	24.8172	24.9028	24.9884	25.074	25.1596	25.2452

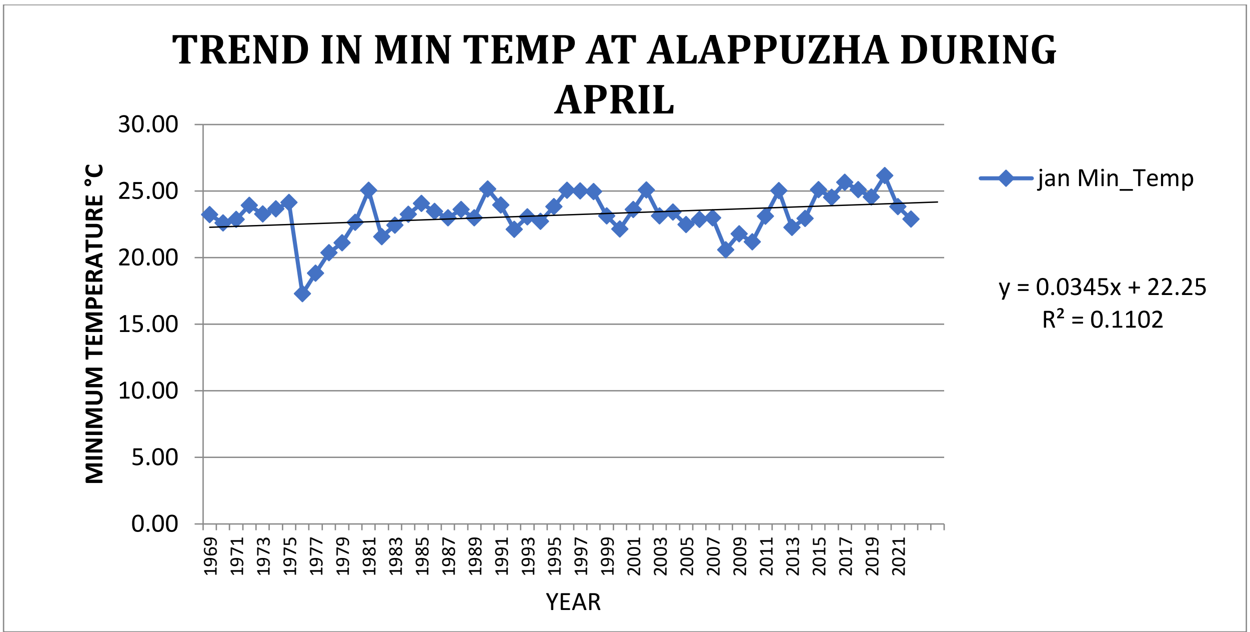

Fig 4.16. Trends in Minimum Temperature at Alappuzha during April

Table 4.16. Predicted Minimum Temperature at Alappuzha in April for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in April	24.18	4.22	24.25	24.29	24.32	24.354	24.39

From Fig 4.16, it could be observed that there is an upward trend in Minimum Temperature during April. The regression model estimated is $Y_t = 0.0345\, X_t + 22.25$ with an R^2 of 0.1102, indicating 11.02 % of variation that can be explained by this model. From the trend it could be observed that the coming April season will be hot as given in the forecasts in Table 4.16.

Table 4.16. Predicted Minimum Temperature at Alappuzha in April for 2024 to 2030

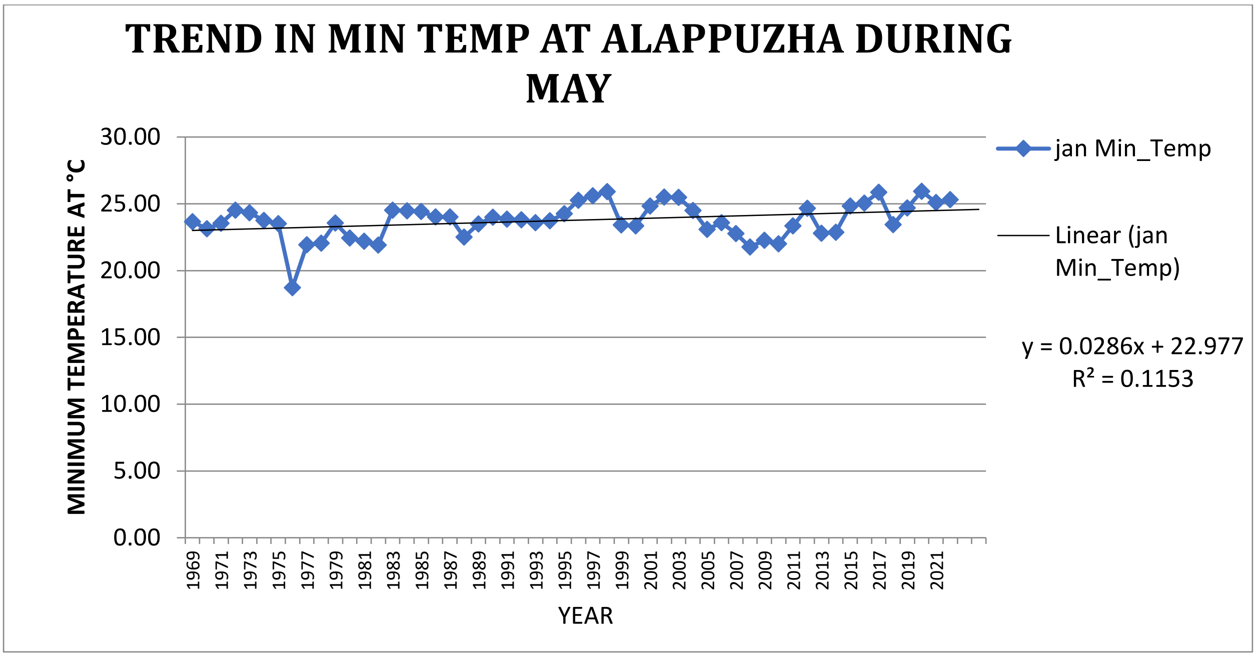

Fig 4.17. Trends in Minimum Temperature at Alappuzha during May

From Fig 4.17, it could be observed that there is an upward trend in Minimum Temperature during May. The regression model estimated is $Y_t = 0.0286\, X_t + 22.977$ with an R^2 of 0.1153, indicating 11.53 % of variation that can be explained by this model. From the trend it could be observed that the coming May season will be hot as given in the forecasts in Table 4.17.

Table 4.17. Predicted Minimum Temperature at Alappuzha in May for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in may	24.5786	24.6072	24.6644	24.6644	24.693	24.7216	24.7502

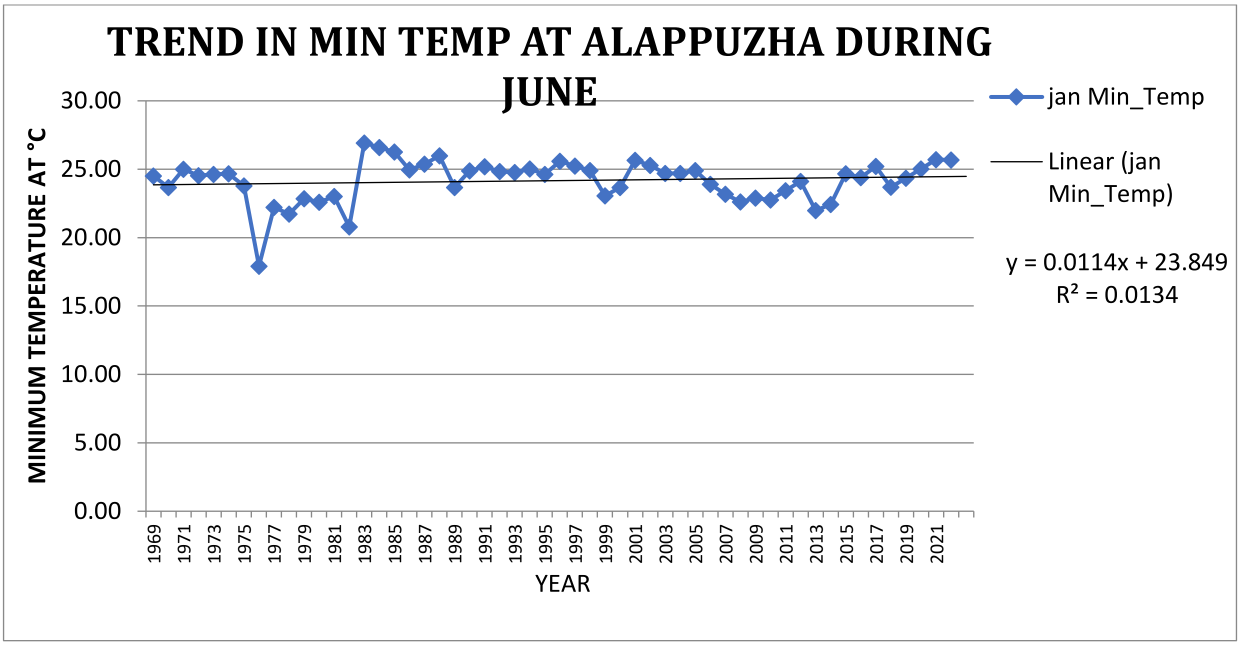

Fig 4.18. Trends in Minimum Temperature at Alappuzha during June

From Fig 4.18, it could be observed that there is an upward trend in Minimum Temperature during June. The regression model estimated is $Y_t = 0.0114\ X_t + 23.849$with an R^2 of 0.0134, indicating 1.34% of variation that can be explained by this model. From the trend it could be observed that the coming June season will be hot as given in the forecasts in Table 4.18.

Table 4.18. Predicted Minimum Temperature at Alappuzha in June for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in June	25.340	25.3986	25.4564	25.5142	25.572	25.6298	25.6876

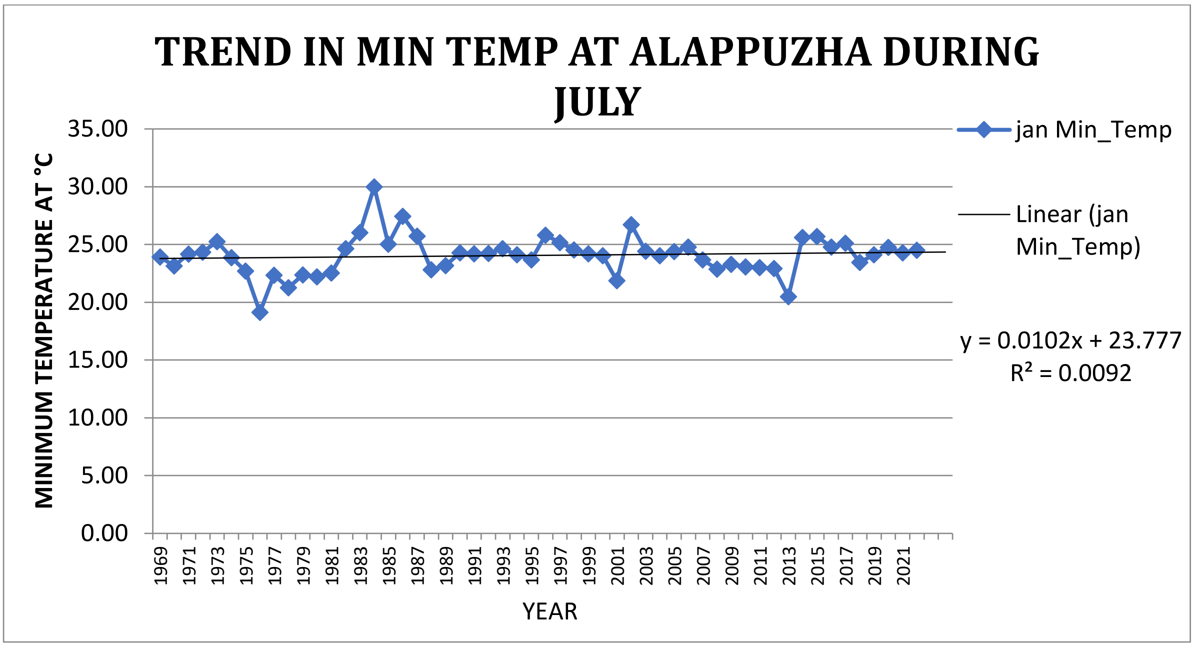

Fig 4.19. Trends in Minimum Temperature at Alappuzha during July

From Fig 4.19, it could be observed that there is an upward trend in Minimum Temperature during July. The regression model estimated is Y_t= 0.0102 X_t + 23.777 with an R^2 of 0.0092, indicating .92% of variation that can be explained by this model. From the trend it could be observed that the coming July season will be hot as given in the forecasts in Table 4.19.

Table 4.19. Predicted Minimum Temperature at Alappuzha in July for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in July	24.348	24.358	24.358	24.378	24.389	24.399	24.409

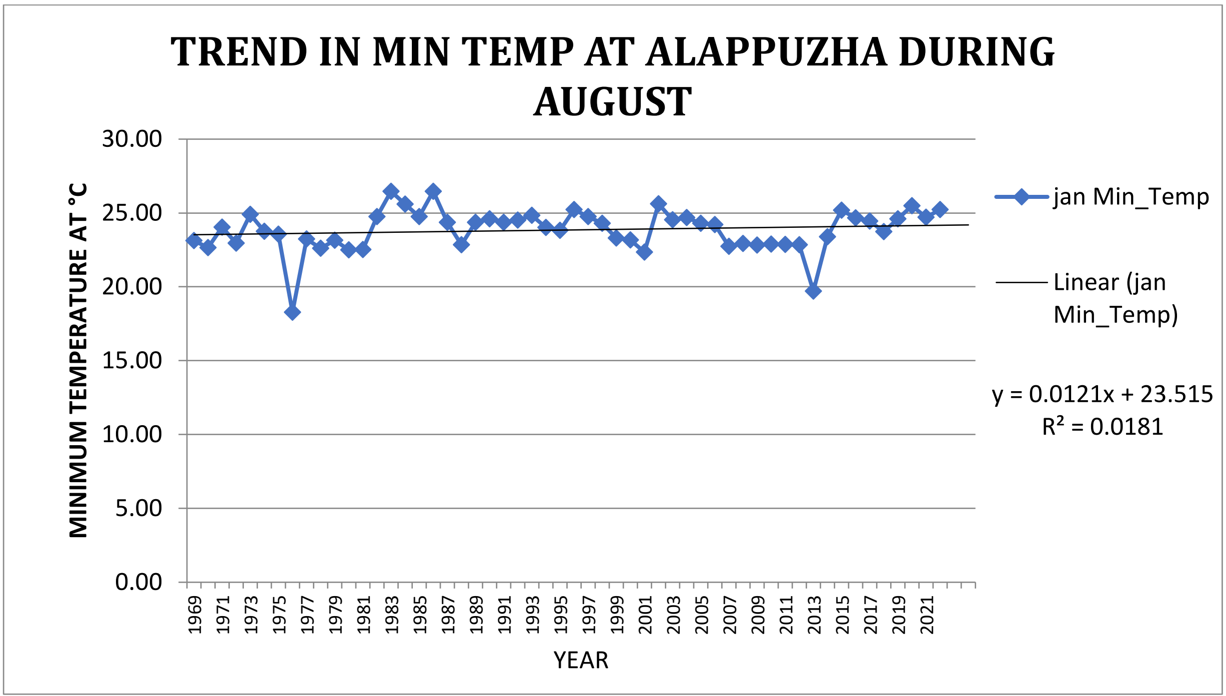

Fig 4.20. Trends in Minimum Temperature at Alappuzha during August

From Fig 4.20, it could be observed that there is an upward trend in Minimum Temperature during August. The regression model estimated is Y_t= 0.0121 X_t + 23.515 with an R^2 of 0.0181, indicating 1.81% of variation that can be explained by this model. From the trend it could be observed that the coming August season will be hot as given in the forecasts in Table 4.20.

Table 4.20. Predicted Minimum Temperature at Alappuzha in August for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in August	24.192	24.204	24.2168	24.228	24.241	24.253	24.265

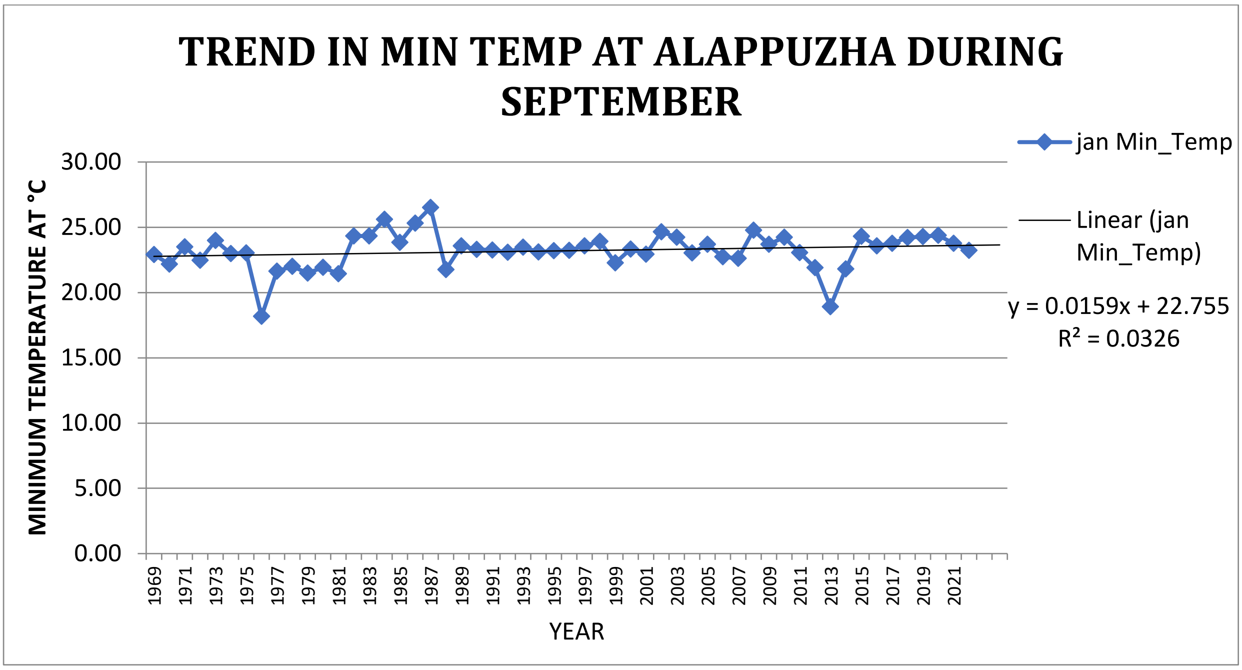

Fig 4.21. Trends in Minimum Temperature at Alappuzha during September

From Fig 4.21, it could be observed that there is an upward trend in Minimum Temperature during September. The regression model estimated is Y_t =0.0159 X_t + 22.755 with an R^2 of 0.0326, indicating 3.26 % of variation that can be explained by this model. From the trend it could be observed that the coming September season will be hot as given in the forecasts in Table 4.21.

Table 4.21. Predicted Minimum Temperature at Alappuzha in September for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in September	23.645	23.661	23.677	23.693	23.709	23.724	23.740

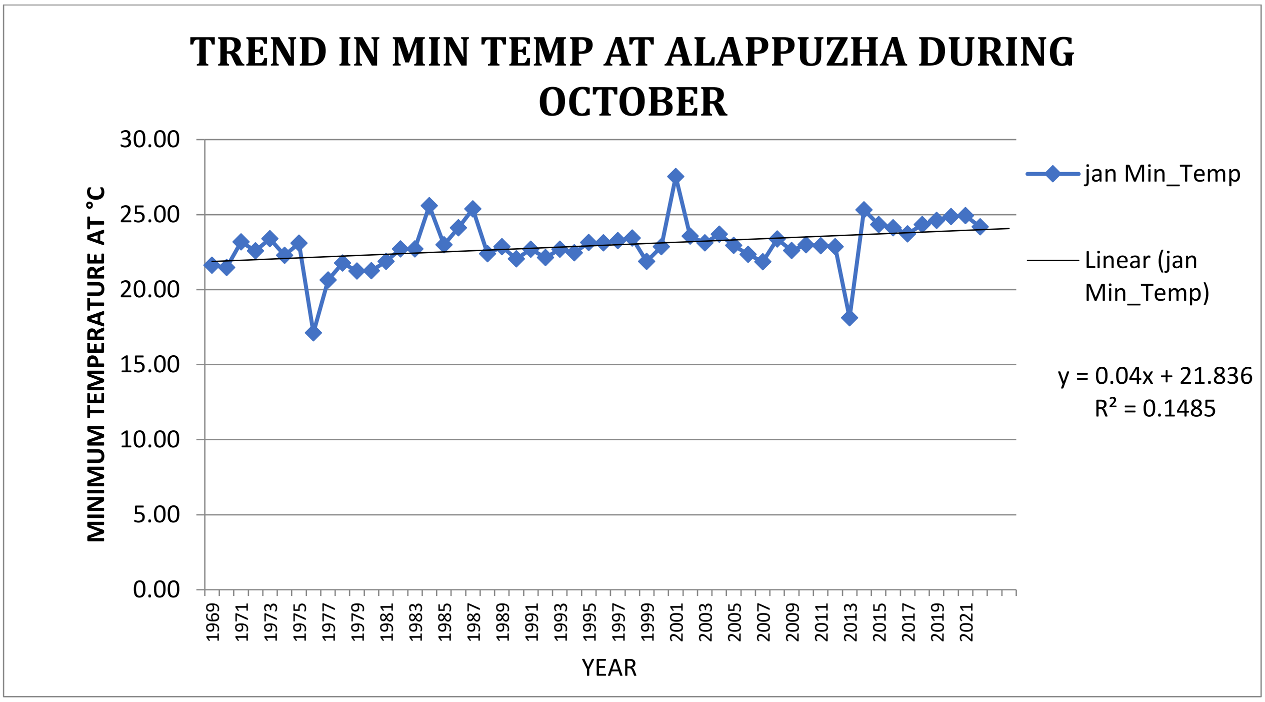

Fig 4.22. Trends in Minimum Temperature at Alappuzha during October

From Fig 4.22, it could be observed that there is an upward trend in Minimum Temperature during October. The regression model estimated is $Y_t = 0.04\ X_t + 21.836$ with an R^2 of 0.1485, indicating 14.85 % of variation that can be explained by this model. From the trend it could be observed that the coming September season will be hot as given in the forecasts in Table 4.22.

Table 4.22. Predicted Minimum Temperature at Alappuzha in October for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in October	23.076	24.116	24.156	24.196	24.236	24.276	24.316

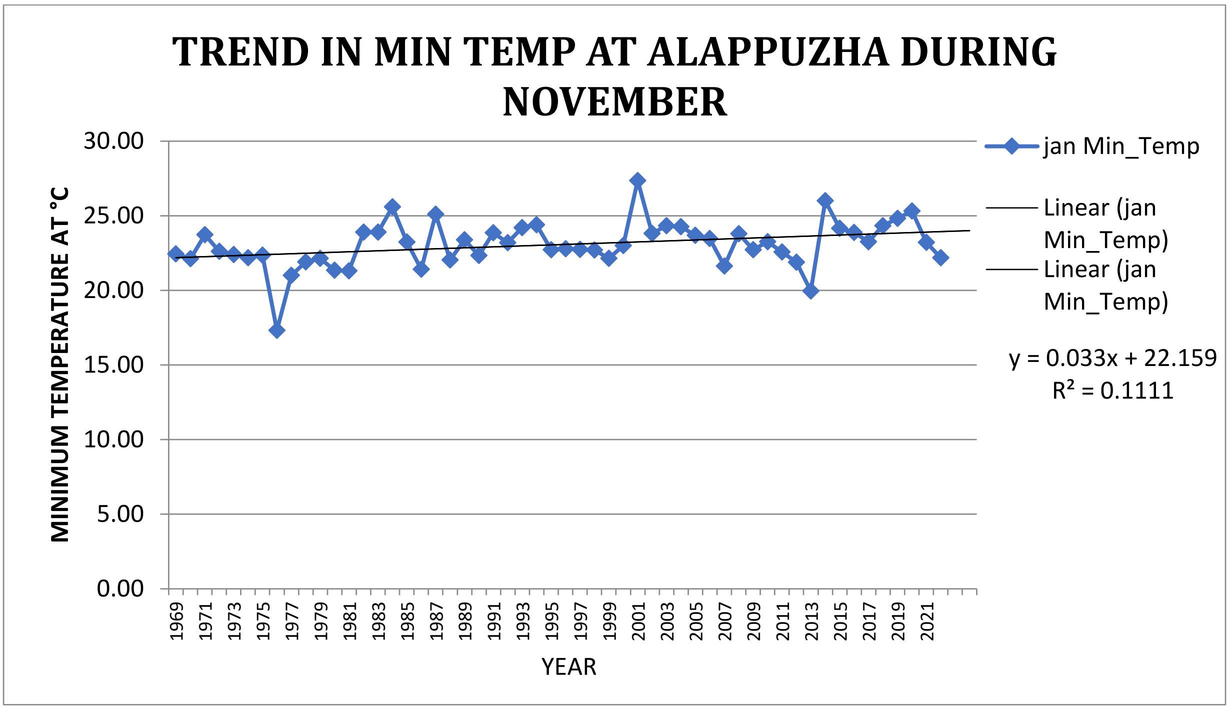

Fig 4.23. Trends in Maximum Temperature at Alappuzha during November

From Fig 4.23, it could be observed that there is an upward trend in Minimum Temperature during November. The regression model estimated is $Y_t = 0.033\ X_t + 22.159$ with an R^2 of 0.1111, indicating 11.11 % of variation that can be explained by this model. From the trend it could be observed that the coming November season will be hot as given in the forecasts in Table 4.23.

Table 4.23. Predicted Minimum Temperature at Alappuzha in November for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in November	24.007	24.04	24.073	24.106	24.139	24.172	24.205

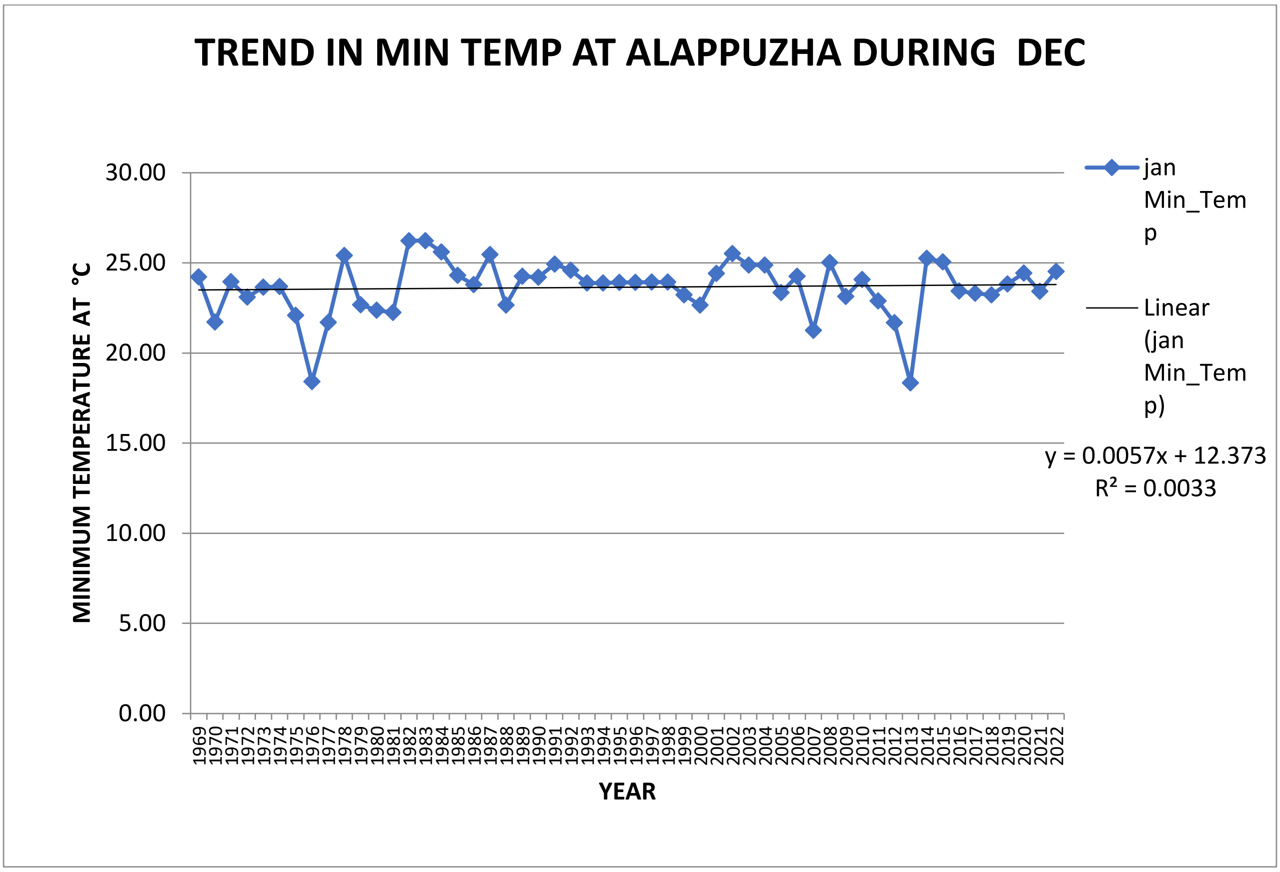

Fig 4.24. Trends in Maximum Temperature at Alappuzha during December

From Fig 4.24, it could be observed that there is an upward trend in Minimum Temperature during December. The regression model estimated is $Y_t = 0.0057 X_t + 23.493$ with an R^2 of 0.0033, indicating 0.33% of variation that can be explained by this model. From the trend it could be observed that the coming December season will be hot as given in the forecasts in Table 4.24.

Table 4.24. Predicted Minimum Temperature at Alappuzha in December for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Max Temp in December	23.8122	23.8179	23.8236	23.8293	23.835	23.8407	23.8464

Trend in Rainfall

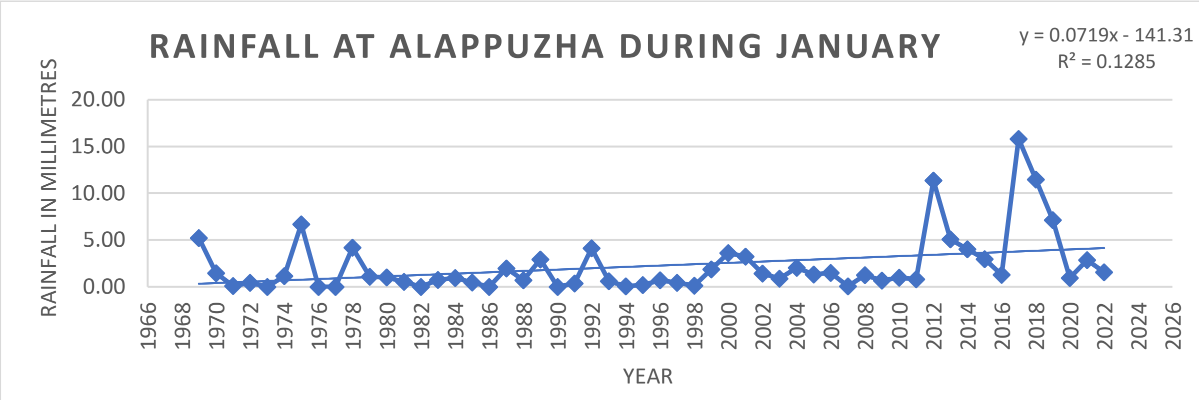

Fig 4.25. Trends in Rainfall at Alappuzha during January

From Fig 4.25, it could be observed that there is an upward trend in Rainfall during January. The regression model estimated is Y_t = 0.0719 X_t - 141.31 with an R^2 of 0.1285, indicating 12% of variation that can be explained by this model. From the trend it could be observed that the coming January season will be experiencing slightly high rainfall as given in the forecasts in Table 4.25.

Table 4.25. Predicted Rainfall at Alappuzha in January for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Rainfall in January	4.2156	4.2875	4.3594	4.4313	4.5032	4.5751	4.647

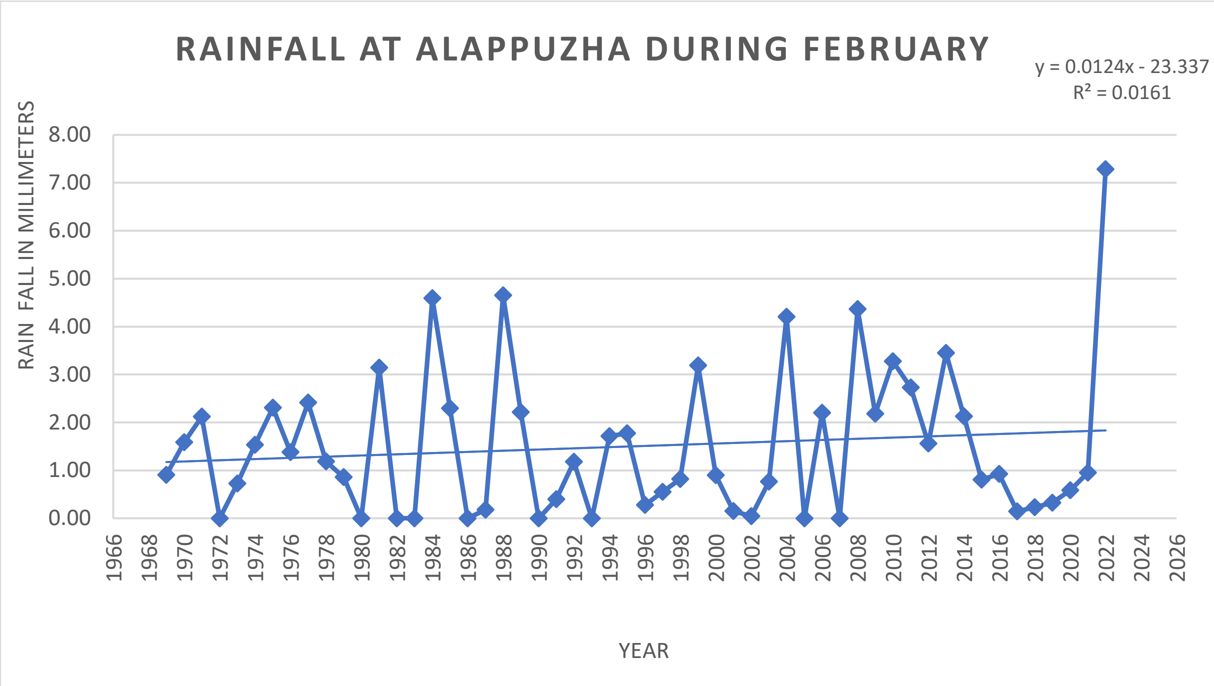

Fig 4.26. Trends in Rainfall at Alappuzha during February

From Fig 4.26, it could be observed that there is an upward trend in Rainfall during February. The regression model estimated is YY_{tt} = 0.0124 X_t - 23.337 with an R^2 of 0.0161, indicating 1.61% of variation that can be explained by this model. From the trend it could be observed that the coming February season will be experiencing slightly high rainfall as given in the forecasts in Table 4.26.

Table 4.26. Predicted Rainfall at Alappuzha in February for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Rainfall in February	1.760	1.773	1.785	1.797	1.810	1.822	1.835

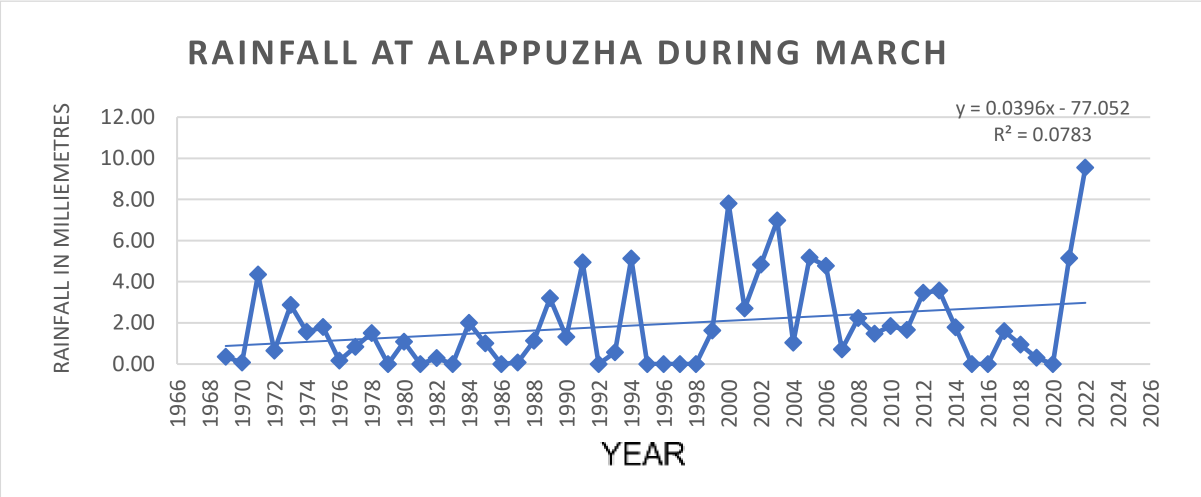

Fig 4.27. Trends in Rainfall at Alappuzha during March

From Fig 4.27, it could be observed that there is an upward trend in Rainfall during March. The regression model estimated is YY_{tt} =0.0396 X_t - 77.0520 with an R^2 of 0.0783, indicating 7.83% of variation that can be explained by this model. From the trend it could be observed that the coming March season will be experiencing slightly high rainfall as given in the forecasts in Table 4.27

Table 4.27. Predicted Rainfall at Alappuzha in March for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Rainfall in March	3.098	3.138	3.177	3.217	3.256	3.296	3.336

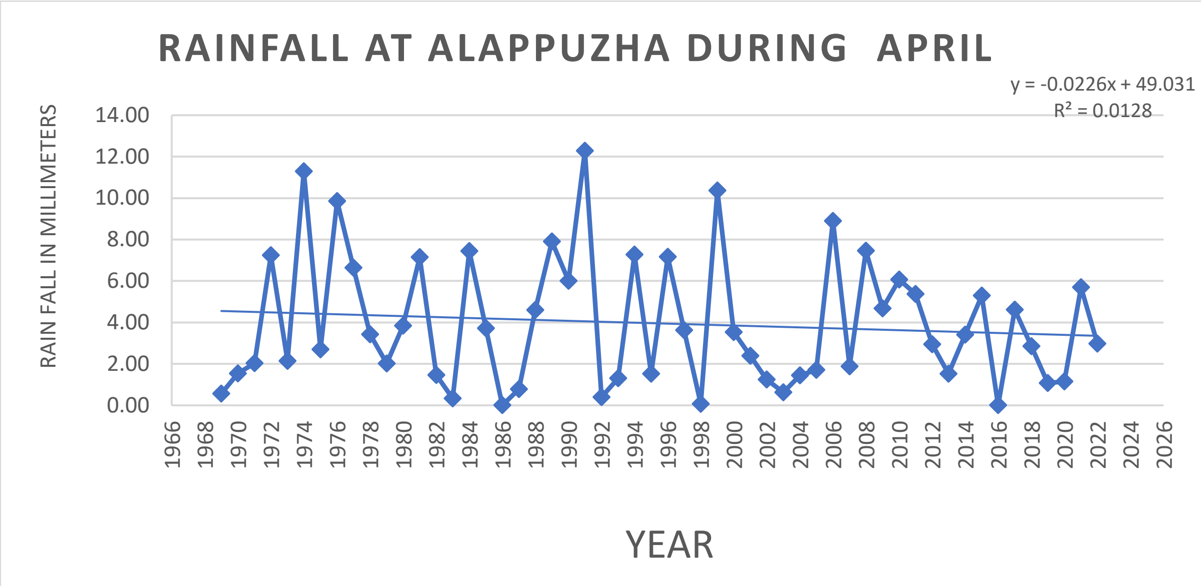

Fig 4.28. Trends in Rainfall at Thiruvananthapuram during April

From Fig 4.28, it could be observed that there is a downward trend in Rainfall during April. The regression model estimated is YY_{tt}= -0.0226 X_t + 49.031 with an R^2 of 0.0128, indicating 1.28% of variation that can be explained by this model. From the trend it could be observed that the coming April season will be experiencing slightly low rainfall as given in the forecasts in Table 4.28.

Table 4.28. Predicted Rainfall at Alappuzha in April for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Rainfall in April	3.288	3.266	3.243	3.220	3.198	3.175	3.153

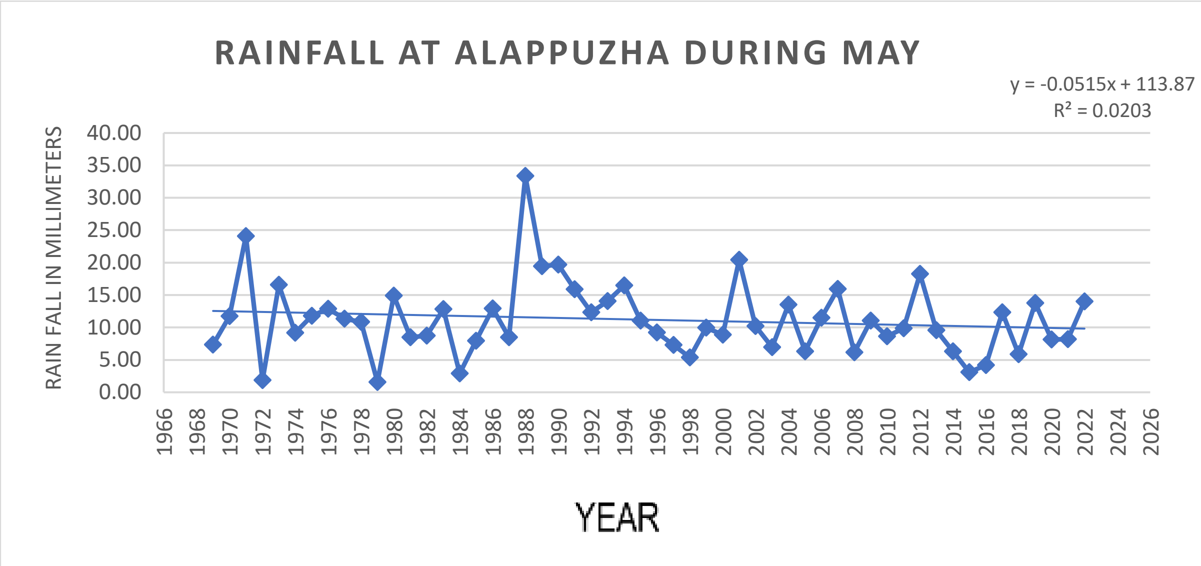

Fig 4.29. Trends in Rainfall at Alappuzha during May

From Fig 4.29, it could be observed that there is a downward trend in Rainfall during May. The regression model estimated is YY_{tt}= -0.0515 X_t + 113.87 with an R^2 of 0.0203, indicating 2.03% of variation that can be explained by this model. From the trend it could be observed that the coming May season will be experiencing slightly low rainfall as given in the forecasts in Table 4.29.

Table 4.29. Predicted Rainfall at Alappuzha in May for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Rainfall in May	9.634	9.582	9.53	9.479	9.428	9.376	9.325

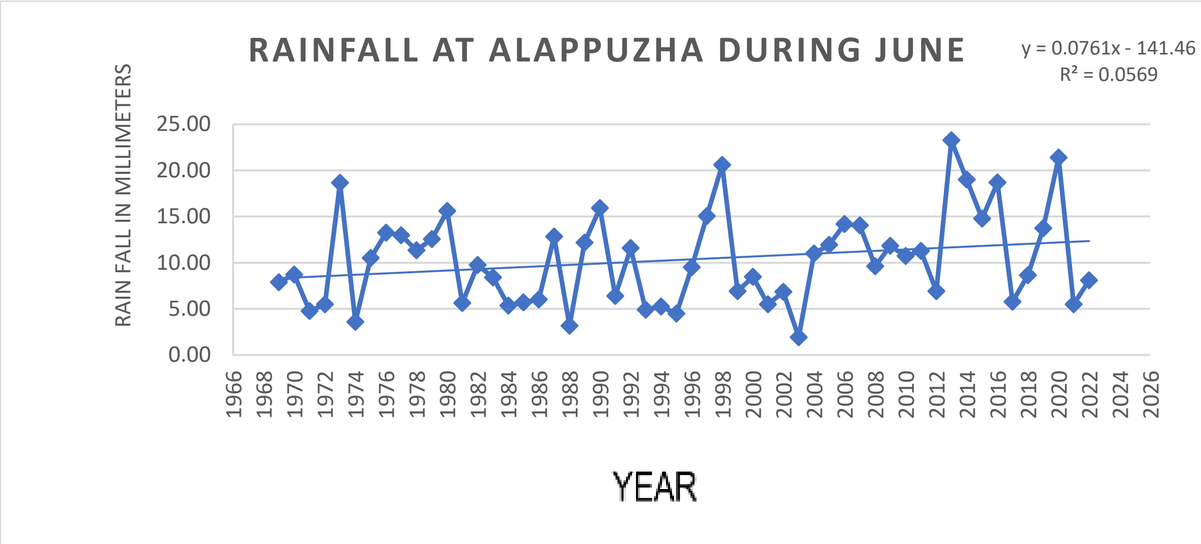

Fig 4.30. Trends in Rainfall at Alappuzha during June

From Fig 4.30, it could be observed that there is an upward trend in Rainfall during June. The regression model estimated is YY_{tt}= 0.0761 X_t - 141.46 with an R^2 of 0.0569, indicating 5.69% of variation that can be explained by this model. From the trend it could be observed that the coming June season will be experiencing slightly high rainfall as given in the forecasts in Table 4.30.

Table 4.30. Predicted Rainfall at Alappuzha in June for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Rainfall in June	12.566	12.642	12.718	12.794	12.870	12.946	13.02

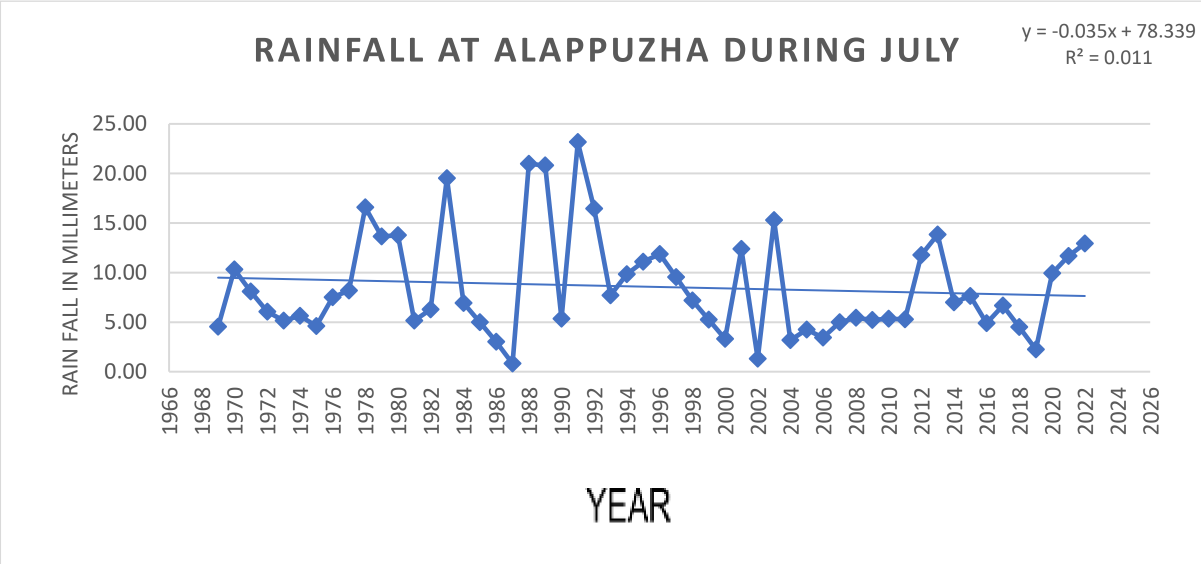

Fig 4.31. Trends in Rainfall at Alappuzha during July

From Fig 4.31, it could be observed that there is a downward trend in Rainfall during July. The regression model estimated is YY_{tt}= -0.035 X_t + 78.339 with an R^2 of 0.011, indicating 1.1% of variation that can be explained by this model. From the trend it could be observed that the coming July season will be experiencing slightly low rainfall as given in the forecasts in Table 4.31.

Table 4.31. Predicted Rainfall at Alappuzha in July for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Rainfall in July	7.499	7.464	7.429	7.394	7.359	7.324	7.289

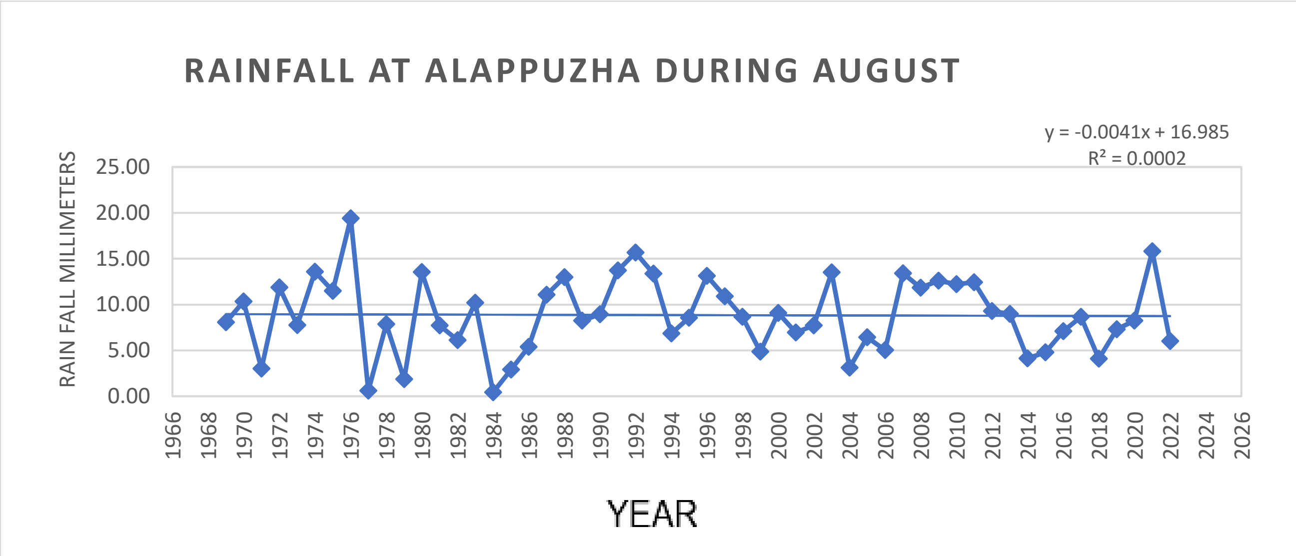

Fig 4.32. Trends in Rainfall at Alappuzha during August

From Fig 4.32, it could be observed that there is a downward trend in Rainfall during August. The regression model estimated is Y_t= -0.0041 X_t + 16.985 with an R^2 of 0.0002, indicating .02% of variation that can be explained by this model. From the trend it could be observed that the coming August season will be experiencing slightly low rainfall as given in the forecasts in Table 4.32

Table 4.32. Predicted Rainfall at Alappuzha in August for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Rainfall in August	8.686	8.682	8.678	8.674	8.670	8.666	8.662

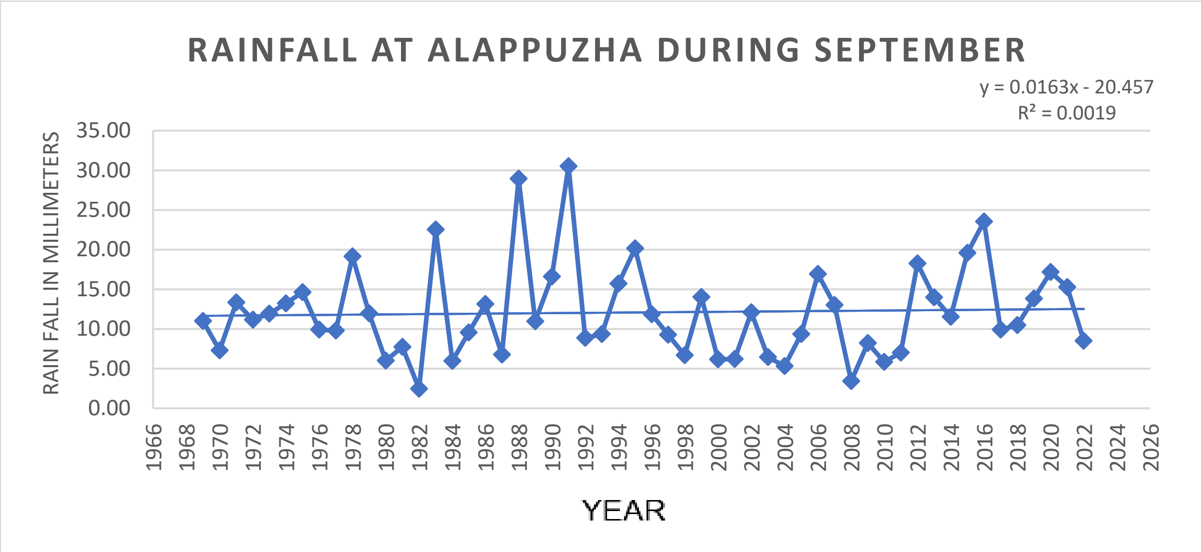

Fig 4.33. Trends in Rainfall at Alappuzha during September

From Fig 4.33, it could be observed that there is an upward trend in Rainfall during September. The regression model estimated is Y_t= 0.0163 X_t - 20.457 with an R^2 of 0.0019, indicating .19% of variation that can be explained by this model. From the trend it could be observed that the coming September season will be experiencing slightly high rainfall as given in the forecasts in Table 4.33.

Table 4.33. Predicted Rainfall at Alappuzha in September for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Rainfall in September	19.544	19.527	19.511	19.495	19.47	19.462	19.446

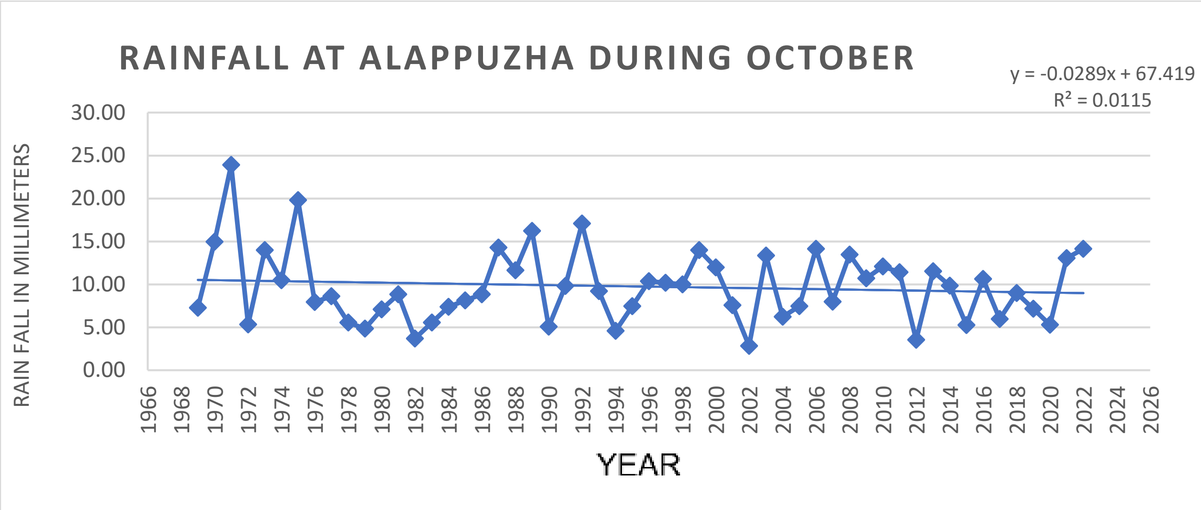

Fig 4.34. Trends in Rainfall at Alappuzha during October

From Fig 4.34, it could be observed that there is a downward trend in Rainfall during October. The regression model estimated is Y_t= -0.0289 X_t + 67.419 with an R^2 of 0.0115, indicating 1.15% of variation that can be explained by this model. From the trend it could be observed that the coming October season will be experiencing slightly low rainfall as given in the forecasts in Table 4.34.

Table 4.34. Predicted Rainfall at Alappuzha in October for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Rainfall in October	8.925	8.896	8.867	8.838	8.809	8.780	8.752

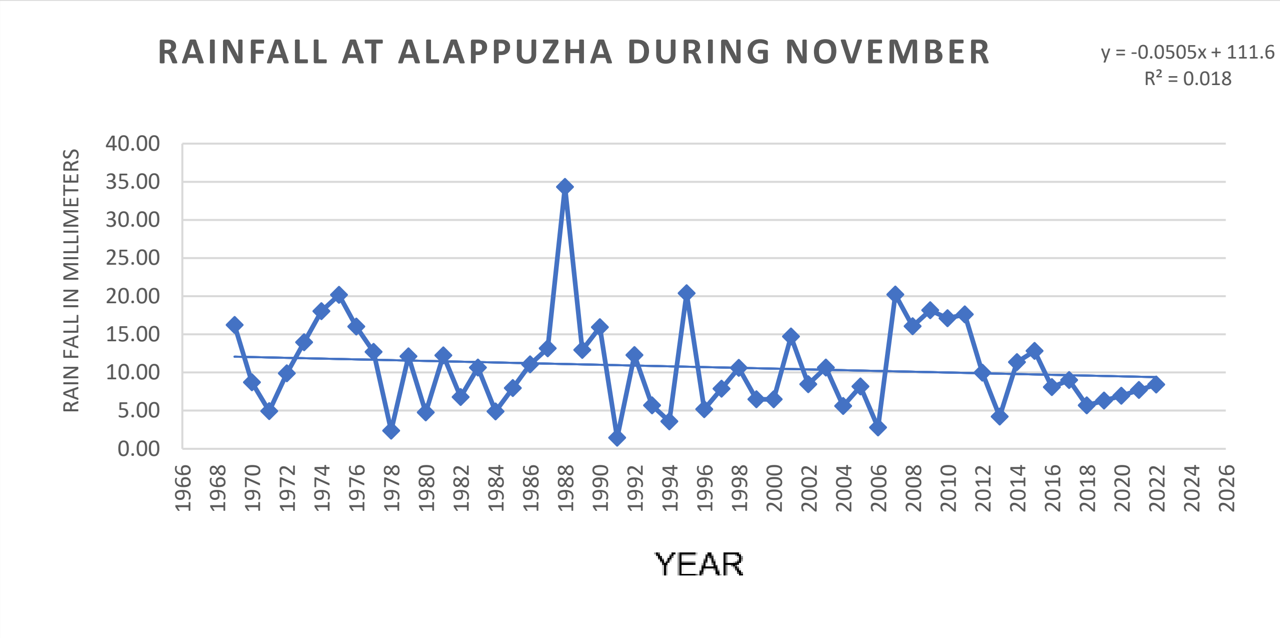

Fig 4.35. Trends in Rainfall at Alappuzha during November

From Fig 4.35, it could be observed that there is a downward trend in Rainfall during November. The regression model estimated is Y_t= -0.0505 X_t + 111.6 with an R^2 of 0.018, indicating 1.8% of variation that can be explained by this model. From the trend it could be observed that the coming November season will be experiencing slightly low rainfall as given in the forecasts in Table 4.35.

Table 4.35. Predicted Rainfall at Alappuzha in November for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Rainfall in November	9.388	9.337	9.28	9.236	9.186	9.135	9.085

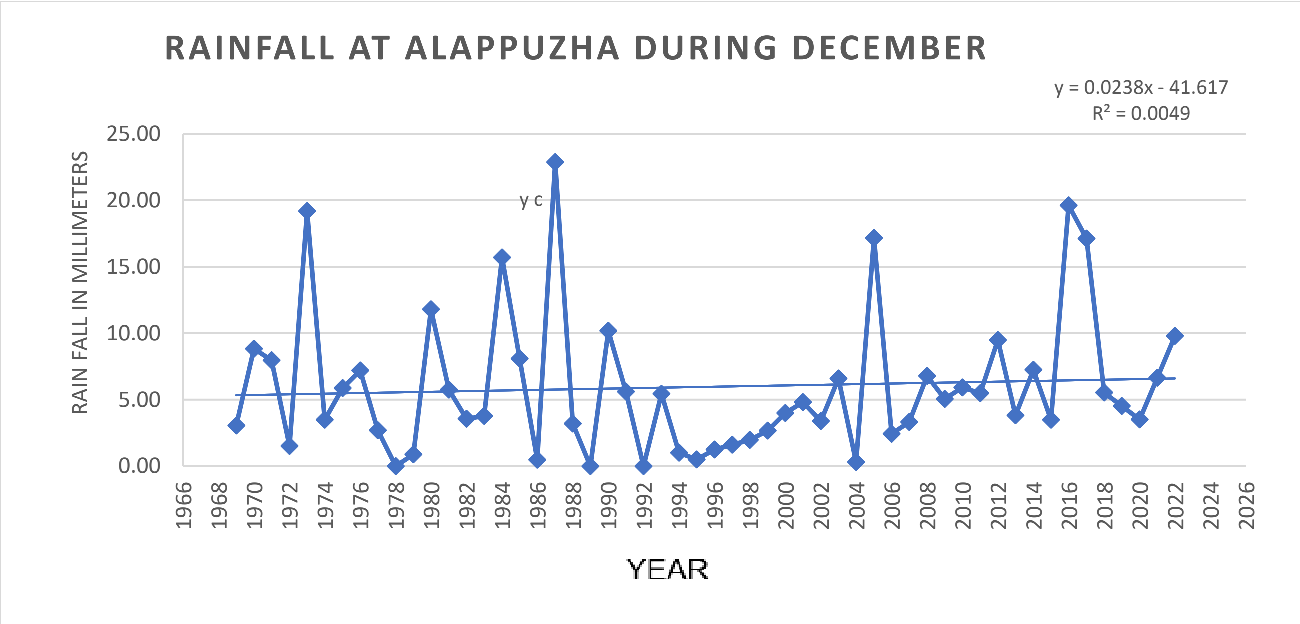

Fig 4.36. Trends in Rainfall at Alappuzha during December

From Fig 4.36, it could be observed that there is an upward trend in Rainfall during December. The regression model estimated is Y_t = 0.0238 X_t - 41.617 with an R^2 of 0.0049, indicating 0.49% of variation that can be explained by this model. From the trend it could be observed that the coming December season will be experiencing slightly high rainfall as given in the forecasts in Table 4.36.

Table 4.36. Predicted Rainfall at Alappuzha in December for 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Expected Rainfall in December	6.554	6.578	6.601	6.625	6.649	6.673	6.697

Autocorrelation

Maximum Temperature

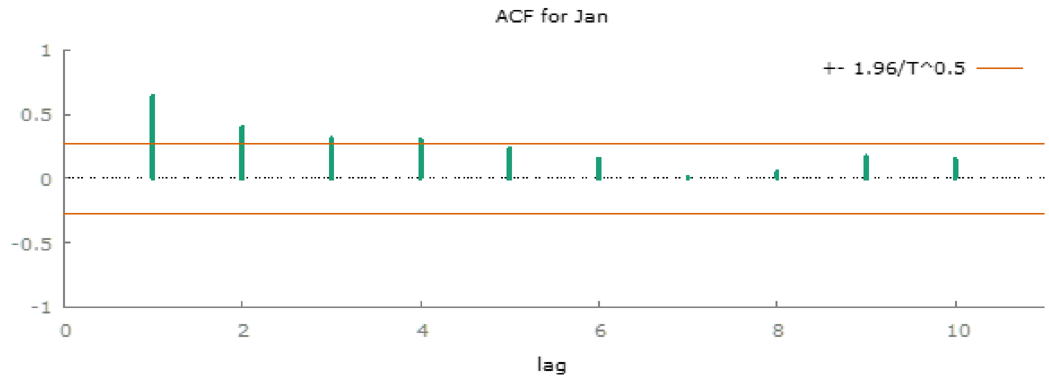

Fig 4.37 Autocorrelation for Maximum Temperature in January.

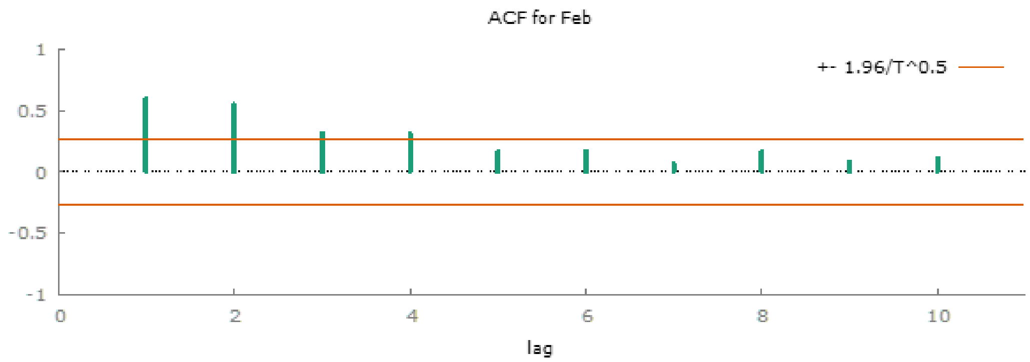

Fig 4.38 Autocorrelation for maximum Temperature in February.

From Fig 4.37 a Fig 4.38 since the bars almost fit inside the 95% confidence interval we can say that they are stationary. Similarly it is found that the rest of the months are stationary.

Minimum Temperature

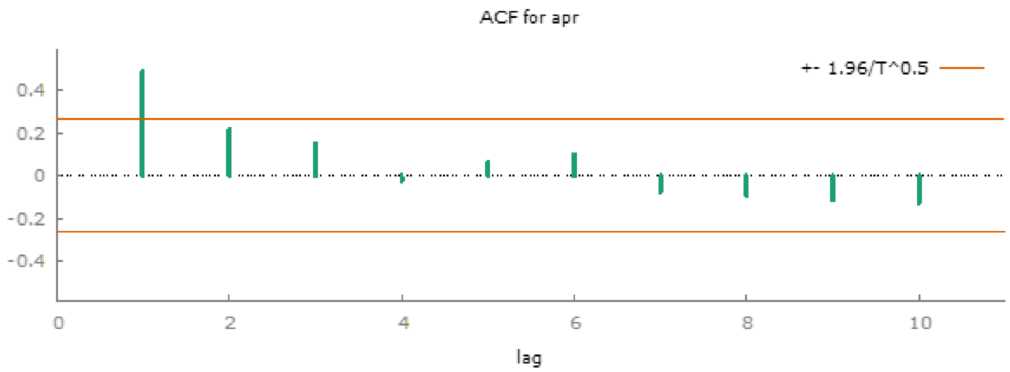

Fig 4.39 Autocorrelation for Minimum Temperature in April

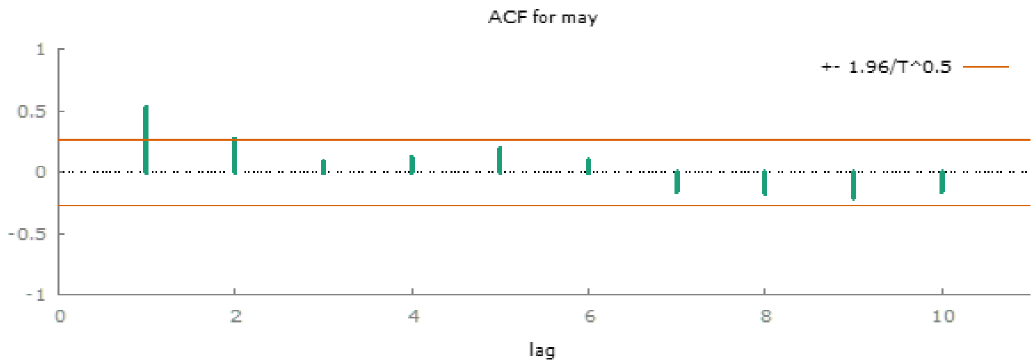

Fig 4.40 Autocorrelation for Minimum Temperature in may

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From Fig 4.39 a Fig 4.40 since the bars almost fit inside the 95% confidence interval we can say that they are stationary. Similarly it is found that the rest of the months are stationary.

Rainfall

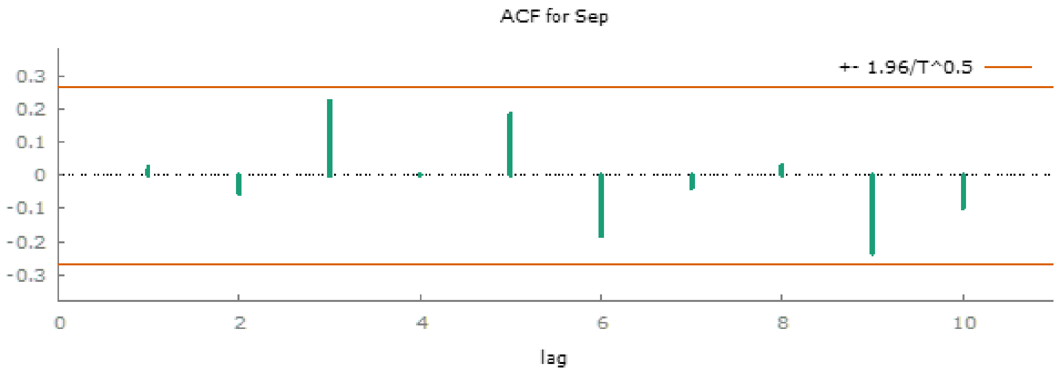

Fig 4.42 Autocorrelation for rainfall Temperature in September

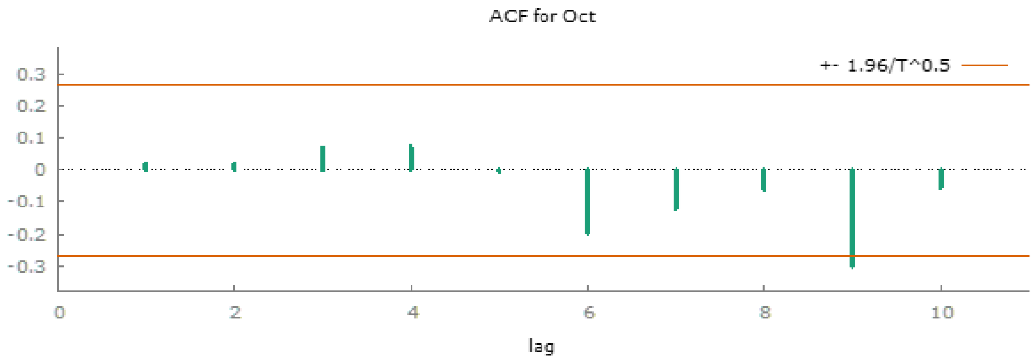

Fig 4.41 Autocorrelation for rainfall Temperature in October.

From Fig 4.41 a Fig 4.42 since the bars almost fit inside the 95% confidence interval we can say that they are stationary. Similarly, it is found that the rest of the months are stationary.

Seasonal Components

Data were tested for stationarity using autocorrelation. It was found that the data were stationary. The time periods were split in to two equal halves ranging from 1969 to 1995 and 1996 to 2022 and seasonal indices were worked out in each period assuming no significant trend in the data

Maximum Temperature

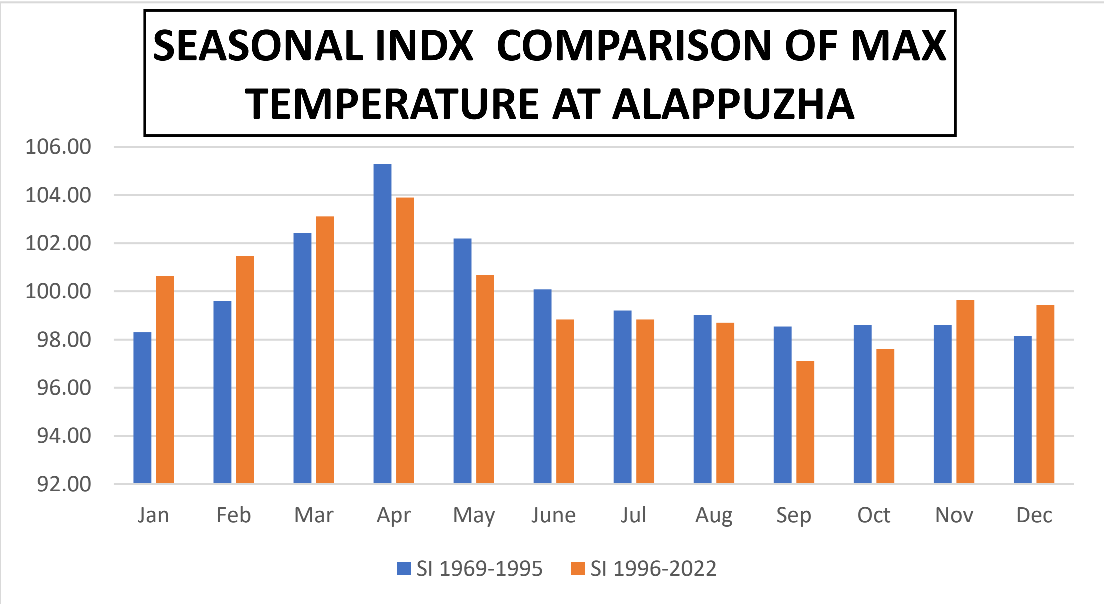

Fig 4. 43. Seasonal indices in Maximum Temperature for Alappuzha

From Fig 4.43, it could be seen that there is a shift in seasonal indices in each month. The maximum temperature was increased during January, February, march, November, December. The maximum temperature is maximum in April in the recent years data, whereas it was high in April before 1995. To test this variation is significant, a paired t-test was done using these data in different time periods. The test resulted a t- value of -1.7226, Which was not statistically significant as the p-value is 0.11499

Minimum Temperature

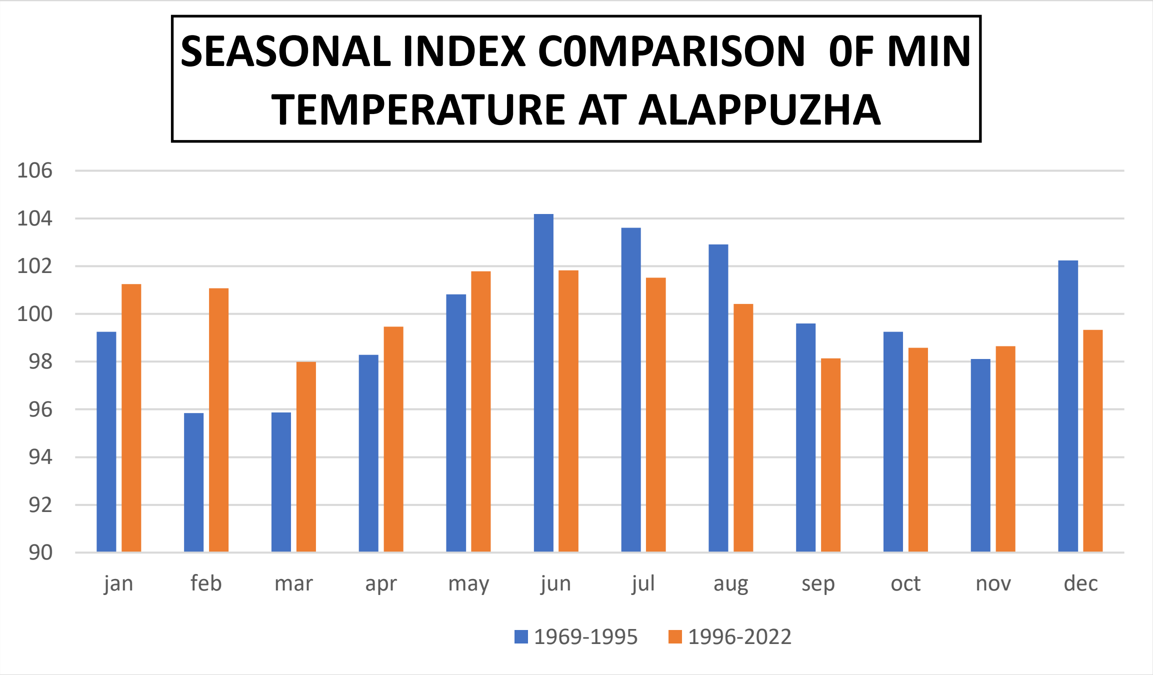

Fig 4. 44. Seasonal indices in Minimum Temperature for Alappuzha

From Fig 4.44, it could be seen that there is a shift in seasonal indices in each month. The minimum temperature was increased during January, February, March, April, May, November. The minimum temperature is maximum in June in the recent years data, whereas it was also high in June before 1995. To test this variation is significant, a paired t-test was done using these data in different time periods. The test resulted a t- value of -3.9549, Which was statistically significant as the p-value is 0.00097656.

Rainfall

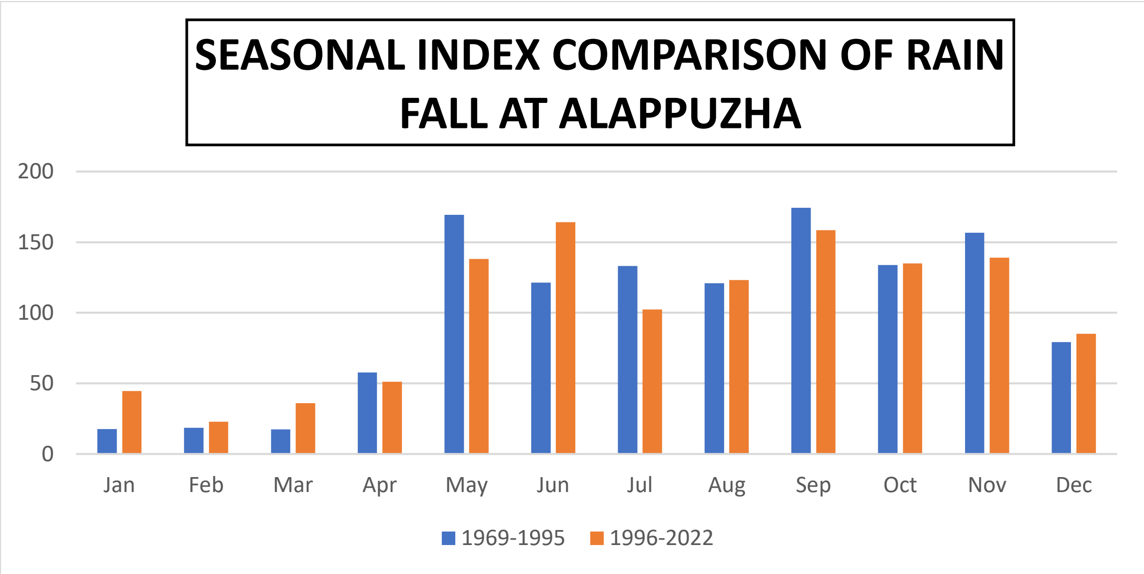

Fig 4. 45. Seasonal indices in Rainfall for Alappuzha

From Fig 4.45, it could be seen that there is a shift in seasonal indices in each month. The rainfall was increased during January, February, March, June, August, October, December. The rainfall is maximum in June in the recent years data, whereas it was high in September before 1995. To test this variation is significant, a paired t-test was done using these data in different time periods. The test resulted a t- value of 0.61297, Which was not statistically significant as the p-value is 0.55236

CHAPTER 5

CONCLUTION

5.1 Summary

The study based on ‘Temporal Shifts: Exploring Temperature and Rainfall Trends In Alappuzha District’ was conducted by students of Sri. C. Achutha Menon Government College, Thrissur by collecting secondary data from Indian Meteorological Department (IMD). Time series plots, trend estimation and seasonal indices were worked out for this data. Other statistical analysis, including paired t-test were conducted for comparing data in different time periods to check whether there is any shift in temperature or rainfall. This was conducted using the PAST software. Data were tested for stationarity using autocorrelation in the Gretl software.

5.2 Conclusion

This study shows that the maximum temperature from the time period 1969 to 2022 is maximum in April and minimum in September and the minimum temperature is maximum in June and minimum in March. The Rainfall is maximum in September and minimum in February.

Table 5.1 Trends in Maximum Temperature in different months at Alappuzha

Month	**Regression Model**	**R^2**
January	Y_t =0.0258 x_t -20.645	0.1817
February	Y_t = 0.0114x_t+ 8.2965	0.0308
March	Y_t = -0.0042 x_t + 40.128	0.0031
April	Y_t =-0.0127 x_t + 57.821	0.0337
May	Y_t =0.0104 x_t +52.151	0.0346
June	Y_t =-0.0053 x_t + 41.405	0.0151
July	Y_t = 0.0041x_t +22.52	0.0054
August	Y_t = 0.005x_t +20.571	0.0102
September	Y_t = -0.0061x_t +30.483	0.0135
October	Y_t = -0.0044x_t +39.172	0.0055
November	Y_t = 0.0212x_t -11.691	0.1626
December	Y_t = 0.019x_t -7.3461	0.1465

Table 5.2 Trends in Minimum Temperature in different months at Alappuzha

Month	**Regression Model**	**R^2**
January	Y_t =0.0388 x_t +22.477	0.0848
February	Y_t = 0.1039x_t +19.785	0.2072
March	Y_t = 0.0437x_t +21.549	0.144
April	Y_t = 0.03454x_t +22.25	0.1102

May	Y_t = 0.0286x_t +22.977	0.1153
June	Y_t = 0.0114x_t +23.849	0.0134
July	Y_t = 0.0102x_t +23.777	0.0092
August	Y_t = 0.0121x_t +23.515	0.0181
September	Y_t = 0.0159x_t +22.755	0.0326
October	Y_t = 0.04 x_t +21.836	0.1485
November	Y_t = 0.033x_t +22.159	0.1111
December	Y_t = 0.0057 x_t +23.493	0.0033

Table 5.3 Trends in Rainfall on different months at Alappuzha

Month	**Regression Model**	**R^2**
January	Y_t = 0.0719 x_t -141.31	0.1285
February	Y_t = 0.0124x_t -23.337	0.0161
March	Y_t = 0.0396x_t -77.052	0.0783
April	Y_t = -0.0226x_t + 49.031	0.0128
May	Y_t = -0.0515 x_t +113.87	0.0203
June	Y_t = 0.0761x_t -141.46	0.0569
July	Y_t = -0.035x_t +78.339	0.011
August	Y_t = -0.0041x_t +16.985	0.0002
September	Y_t = 0.0163x_t -20.457	0.0019
October	Y_t = -0.0289x_t +67.419	0.0115
November	Y_t = -0.0505x_t +111.6	0.012
December	Y_t = 0.0238x_t -41.617	0.0049

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