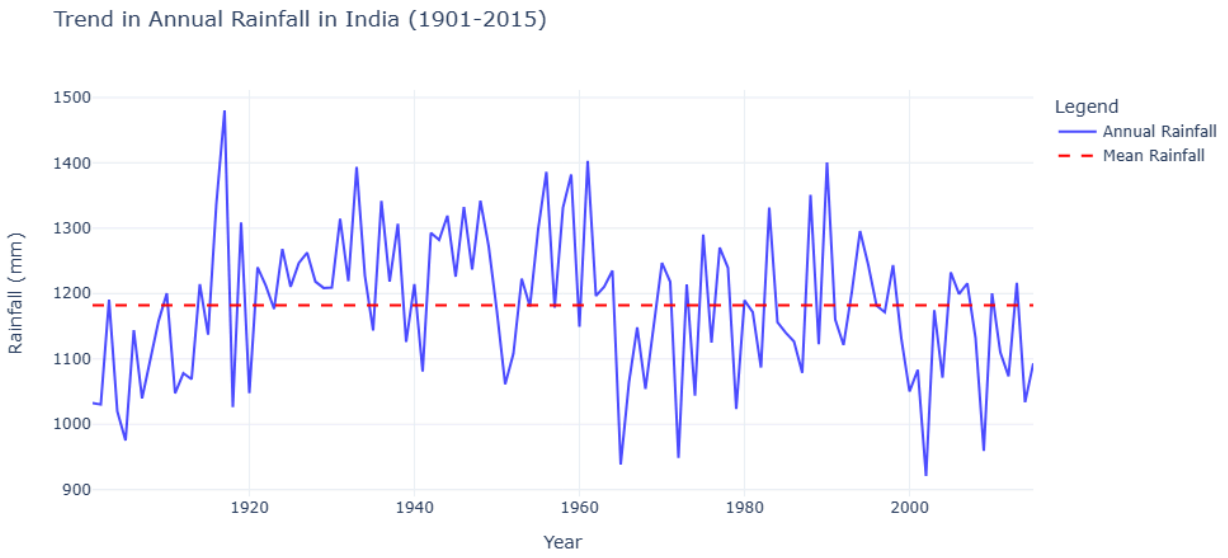
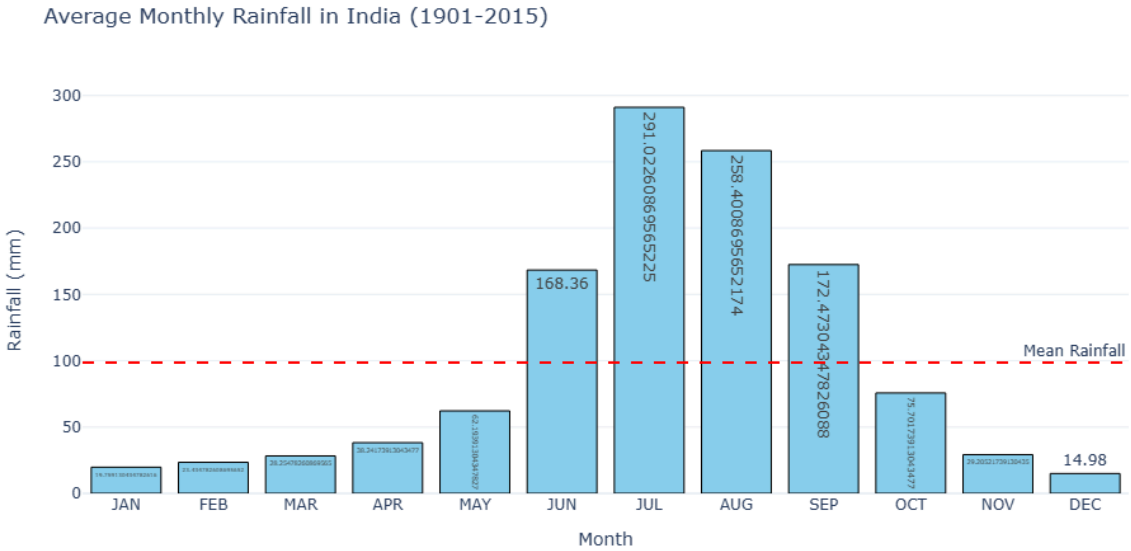
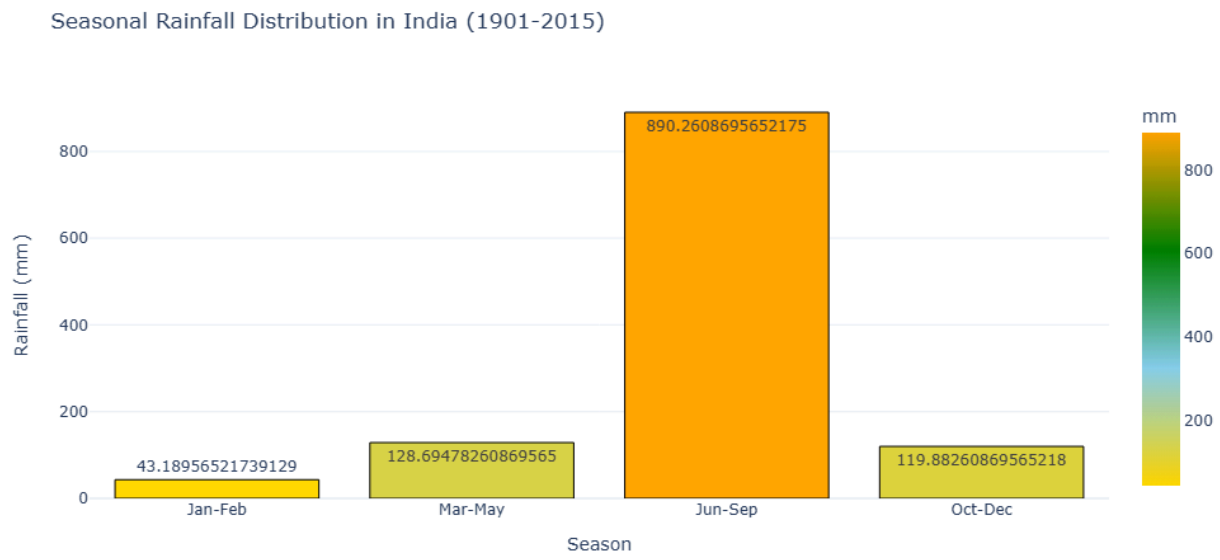
Rainfall Trends in India Analysis- Python (Explanation)



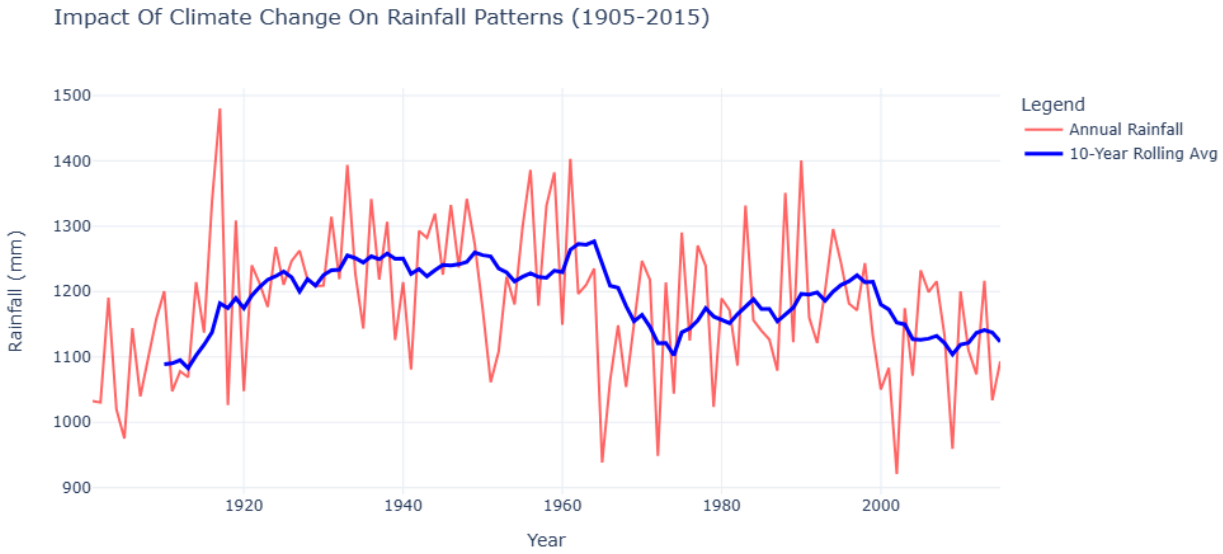
The above graph shows significant year-to-year variability in India's annual rainfall, with no apparent long-term upward or downward trend over the century. The red dashed line indicates the mean rainfall, around which the annual rainfall oscillates. Notable peaks and troughs highlight extreme rainfall events and dry years.



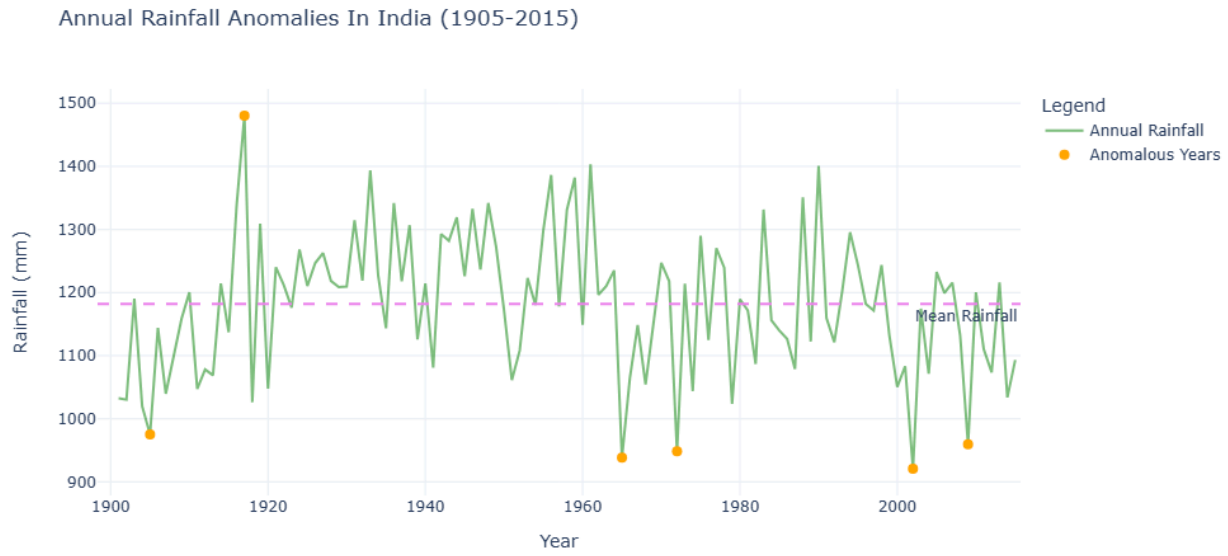
Above bar chart illustrates a highly uneven distribution of rainfall across months, with July and August receiving the highest average rainfall. The red dashed line represents the mean monthly rainfall, showing that most months receive rainfall below the average, except during the monsoon months (June to September).



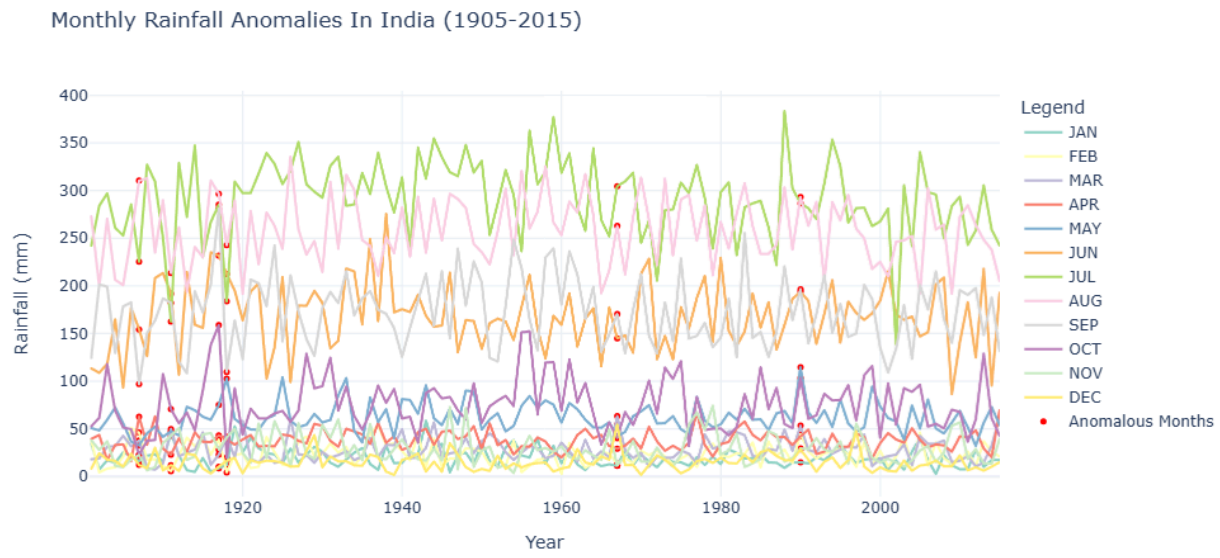
The seasonal distribution highlights the dominance of the monsoon season (June to September), which contributes the bulk of annual rainfall (around 890 mm). In contrast, the other seasons (January-February, March-May, and October-December) contribute significantly less to the annual total, which emphasizes the critical role of the monsoon.



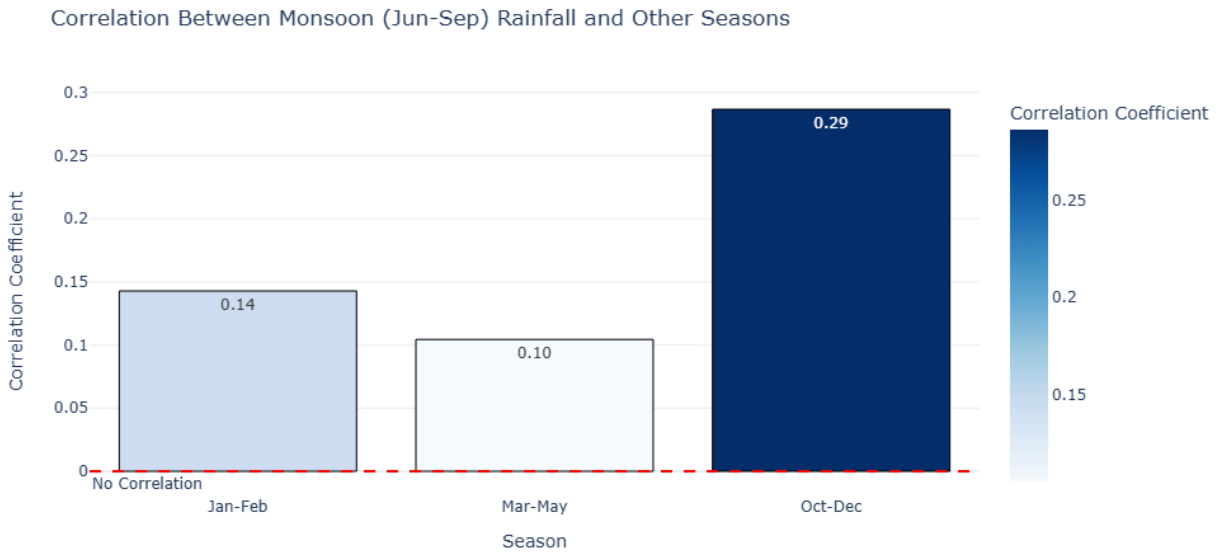
This graph shows the annual rainfall trends in India (blue line) and a 10-year rolling average (red line) to identify long-term patterns. While annual rainfall exhibits significant variability, the 10-year rolling average indicates a slight downward trend post-1960, which suggests a possible impact of climate change on rainfall distribution. Periods of higher averages in the early 20th-century contrast with more consistent but lower averages in recent decades.



This graph highlights years with significant rainfall anomalies, where annual rainfall deviated substantially from the mean. Drought years (e.g., 1905, 1965, 2002) and extreme rainfall years (e.g., 1917, 1961) are marked as red points, which showcase outliers in rainfall patterns. While most years cluster around the mean (green dashed line), the anomalies emphasize the variability in India's rainfall, driven by factors like monsoonal fluctuations and climate events. This underscores the need for monitoring and preparedness for extreme weather events.

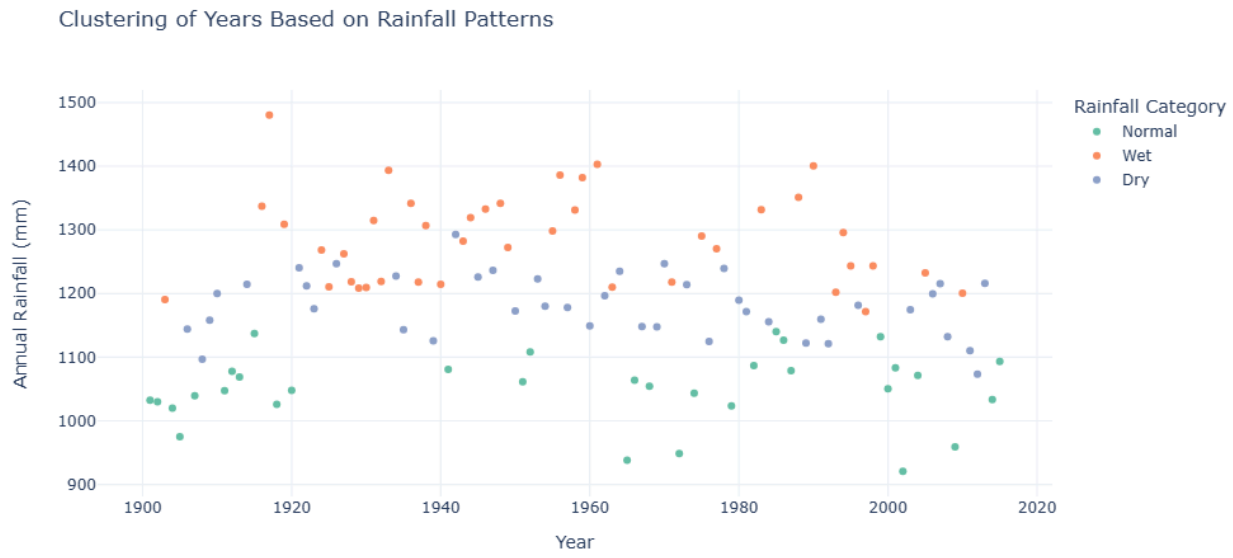


The variability is most pronounced during the monsoon months (June to September), which reflects the critical role of these months in India's rainfall dynamics. Anomalies in non-monsoon months, while less frequent, highlight periods of unusual weather patterns, potentially linked to climate variability or regional disturbances. This graph underscores the uneven distribution and high dependence on monsoonal rainfall for India's water resources.

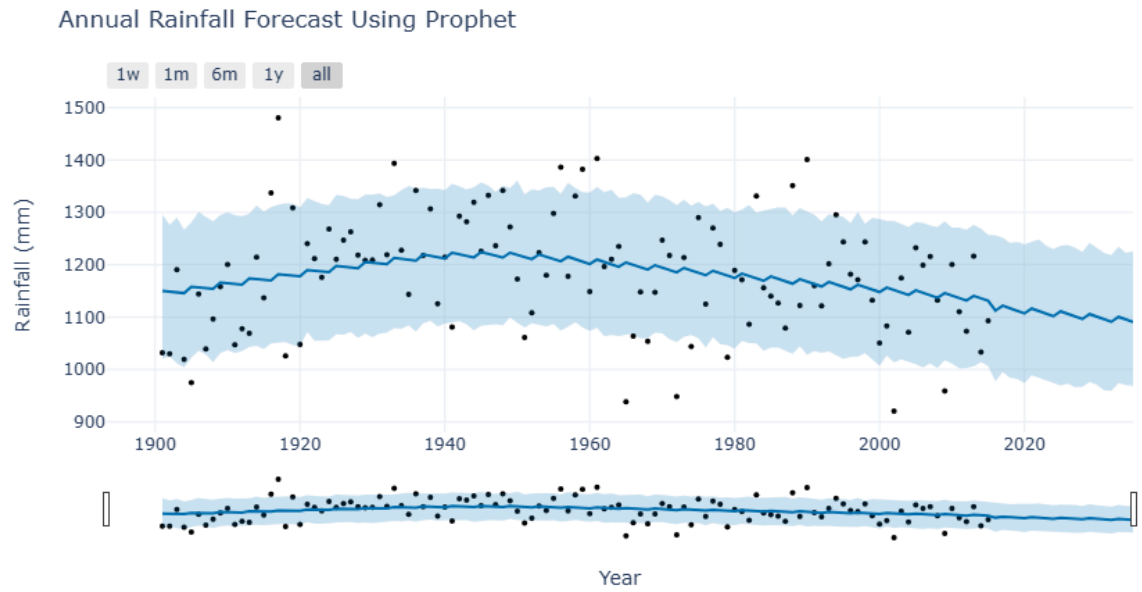


This graph shows the correlation between monsoon rainfall and rainfall during other seasons. The October-December season has the highest correlation (0.29), which suggests a moderate relationship, possibly due to the post-monsoon retreat rains. The January-February (0.14) and March-May (0.10) seasons exhibit weaker correlations, which indicate minimal dependence on

monsoon rainfall. This highlights the dominance of monsoonal patterns as an independent driver of India's annual rainfall, with limited spillover effects on other seasons.



The clusters reveal that most years fall into the Normal category, while Wet years (above-normal rainfall) are sporadically distributed throughout the timeline, with a concentration in the early and mid-20th century. Dry years (below-normal rainfall) are more frequent in the latter half of the timeline, which indicates a potential shift in rainfall patterns over time. This clustering emphasizes the variability and potential long-term changes in India's rainfall dynamics.



The blue line represents the model's forecast trend, while the shaded area indicates the confidence interval. The trend reveals a slight decline in annual rainfall over time, with notable year-to-year variability (black dots representing actual data points). The model captures the variability well but highlights that future rainfall may continue to slightly decrease, which emphasizes the need for adaptive strategies to manage potential water resource challenges.

Conclusion

The analysis of India's rainfall trends and patterns from 1901 to 2015 reveals significant variability in annual and seasonal rainfall, with the monsoon season (June-September) being the dominant contributor. Anomalous years of extreme drought and wetness highlight the unpredictability of rainfall, while clustering shows a shift towards more dry years in recent decades. Correlations indicate the limited dependency of non-monsoon seasons on monsoon rainfall. A time-series forecast using Prophet suggests a slight declining trend in annual rainfall, which emphasises the need for long-term water resource planning and adaptation to changing climate patterns.