International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

A Study on the Footprints of Rainfall Pattern for a Sustainable Climate

Uma G[1], Sneha Babu R[2]

[1]Associate Professor, Department of Statistics, PSG College of Arts & Science, Coimbatore-641014
[2]Post Graduate Student, Department of Statistics, PSG College of Arts & Science, Coimbatore-641014

Abstract

A study on rainfall is a comprehensive summary of existing literature and research related to this meteorological phenomenon. In this century, Limiting and adapting to climate change is the subject of one among seventeen Sustainable Development Goals (SDG 13 or Global Goal 13). The United Nations General Assembly created 17 Sustainable Development Goals in 2015. Take immediate action to mitigate climate change and its effects, according to the goal's stated mission statement. SDG 13 and SDG 7 on clean energy are interconnected and mutually supportive. Recent articles and research study provide a critical analysis of the current knowledge on rainfall and its various aspects, including the processes that generate precipitation, the factors that influence rainfall patterns, the impact of climate change on rainfall, and the methods used to measure and forecast rainfall.Reviews on rainfall serve as a valuable resource for scientists, researchers, and policymakers interested in understanding and managing the effects of rainfall on different aspects of society, such as agriculture, water resource management, and disaster mitigation. The study overviews on rainfall pattern among the different states of India, emphasizing their importance, scope, and contributions to the field of meteorology and offer insights into the latest advances in the field and highlight areas where further research is needed.Overall, review on rainfall are an essential tool for synthesizing and consolidating knowledge on this critical aspect of the Earth's climate system, providing a foundation for informed decision-making and policy development.

Keywords: Climatic Change, SDGs, Rainfall Pattern, Forecasting.

Introduction

India experiences a diverse range of rainfall patterns, varying from region to region. The country's southwest monsoon season, which occurs from June to September, is the most important period for rainfall. During this time, the majority of the country's agricultural activities take place, making the rainfall crucial for India's economy.The most commonly used instrument for measuring rainfall is the rain gauge, which is used to collect and measure the amount of rainfall in a specific area. Other instruments used to measure rainfall include radar, satellites, and weather stations.

The Indian Meteorological Department (IMD) is responsible for monitoring and predicting rainfall in India. The IMD uses a network of rain gauges, weather stations, and Doppler weather radars to gather rainfall data from various regions of the country.Some of the regions in India that receive the highest rainfall include:

The Western Ghats: This region receives heavy rainfall during the southwest monsoon season. The annual average rainfall in this region is between 2500-3500 mm.

The North-eastern region: This region receives heavy rainfall due to the northeast monsoon. The annual average rainfall in this region is between 2000-3000 mm.

The coastal regions of Odisha and Andhra Pradesh: These regions receive heavy rainfall due to cyclonic disturbances. The annual average rainfall in these regions is between 1000-1500 mm.

Overall, rainfall is an essential component of India's climate and economy, and its measurement and monitoring are crucial for understanding and predicting the country's weather patterns. To access the rainfall pattern and their changes, several researchers have been investigated according to rainfall pattern, trend analysis, relationship between the growth of economy.

In present scenario, Sustainable development is essential due to the escalating pressure on natural resources and the environment. The depletion of natural resources, including land, water, forests and minerals has resulted in environment degradation, loss of biodiversity and climate change. The United Nations General Assembly created 17 Sustainable Development Goals in 2015 each with specific objectives and targets to be achieved by 2030. Limiting and adapting to climate change is the subject of one among seventeen Sustainable Development Goals (SDG 13 or Global Goal 13). Take immediate action to mitigate climate change and its effects, according to the goal's stated mission statement. SDG 13 and SDG 7 on clean energy are interconnected and mutually supportive.

By 2030, SDG 13's five aims/objectives must be accomplished. Discuss a wide range of topics relating to climatic changes. The initial three objectives are result objectives: *Build knowledge and capacity to deal with climate change; increase resilience and adaptive capacity to climate-related disasters; and incorporate climate change measures into policies and plans*. Preserving the environment is vital to ensure our planets survival and future generations' wellbeing to live a healthy life.

Literature Review

The study conducted by **Sanikhani et al**. aimed to analyze the trend of rainfall patterns over central India using three different methods: Revised Mann Kendall test (RMK), Sens Slope Estimator, and Innovative Trend Method (ITM). The researchers collected monthly rainfall data from 20 stations in Chhattisgarh and Madhya Pradesh states from the India Meteorological Department (IMD).The results of the study indicated that there was no significant trend in rainfall patterns in January and October. However, the RMK test showed significant trends for five stations in Chhattisgarh, while the ITM test indicated increasing and decreasing significant trends. The significance of the trends increased in November and December using the ITM test.The ITM method has an advantage over other methods, as it can analyze trends without limitations caused by non-normality, serial correlation, or the quantity of data. The study also applied the recently suggested ITM significance test by En (2017b) to rainfall time series for the first time.The findings of this research can be useful for irrigation and water resource planning and management in central India. The ITM method's ability to identify trends accurately and without limitations can be helpful for policymakers and stakeholders to make informed decisions regarding water resource management.

CordeliaNnennaya Mama et al. (2021) investigates the impact of changes in climate and land use on rice productivity in Adani, Nigeria. The study uses satellite images, climate data, and primary data collected through a questionnaire to estimate significant climate factors and understand the trend of rice production in the study area.According to the perceptions of Adani's rice farmers, there has been a

decrease in rice productivity from 1995 to 2019. The study attributes this decline to the negative effects of Climate and land use change (CVC) on the area's poorly draining and water-logged clay soils (dystric fluvisols), which are worsened by nutrient leaching and toxic metal deposition resulting from flooding.To mitigate the negative effects of CVC and improve long-term crop yield in the region, the study suggests adaptation strategies such as using Adani's irrigation facilities to store extra water for use during dry spells and reducing reliance on rain-fed agriculture, which is highly vulnerable to the negative effects of CVC. In addition, the study recommends remediation techniques such as Phyto-remediation to address the problems of nutrient loss and metal toxicity.Overall, the study highlights the need for sustainable land use practices and adaptation strategies to mitigate the negative effects of CVC on rice productivity in Adani and similar regions.

The study aims to analyze the relationship between rainfall variability and economic growth in Indian states using state-level economic and rainfall data from 1961 to 2012. The authors**M. Gilmont et al**. identified three patterns of dependence between rainfall variability and economic growth: Continuous Correlation, Decayed Correlation, and Never Correlated. They found that the link between rainfall variability and economic growth has degraded over time in Indian states that have experienced economic expansion. However, the authors note that it has been challenging to isolate the impact of flooding episodes due to a lack of data and spatial correlation between rainfall and flood incidence. Overall, the study contributes to the development of methodologies for assessing past and ongoing relationships between rainfall variability and economic growth.

Based on the analysis of the rainfall data collected from the Indian Meteorological Department, both positive and negative trends were observed in Ranchi districts, Jharkhand, India, using Sen's slope test and Mann-Kendall (MK) analysis. The magnitude of the slope decreased during the winter and southwest monsoon, while pre- and post-monsoon periods showed an increasing slope magnitude. Winter and annual rainfall had statistically insignificant negative trends, while pre- and post-monsoon rainfall showed a statistically insignificant positive trend.

Further research by **Srinivasa Rao et al.** indicated that the weakening of the tropical easterly jet stream's strength over the Bay of Bengal is critical in bringing rain to India during the southwest monsoon season. Similarly, Chandniha et al. (2017) identified negative Z-statistics values for winter, monsoon, and annual rainfall time series and positive Z-statistics values for pre-monsoon and post-monsoon rainfall time series in the Ranchi districts.The findings from the analysis of rainfall data could be essential for better managing agricultural practices, hydropower production, water resource management, and weather forecasting in the district. By understanding the rainfall patterns and trends, authorities can develop strategies to cope with the variability of rainfall and its effects on different sectors in the area.

The study highlights the significant temporal variations in monthly, seasonal, and annual rainfall over Kerala, India proposed by **Krishnakumar et al.in 2009**. The Mann Kendall rank statistics and Linear trend were used to determine long-term changes in the rainfall pattern. The results of the study showed that there is a significant decrease in southwest monsoon rainfall and an increasing trend in post-monsoon season rainfall. The frequency decline of weather systems over the peninsula in recent years may be an important reason for the decrease in southwest monsoon rainfall.The study also suggests that human activities have impacted Kerala's biophysical resources, leading to alterations in the distribution of local rainfall during the winter and pre-monsoon season. This, in turn, indirectly influences the physical processes that take place inside the earth-atmosphere continuum.

Furthermore, the study points out that the increased frequency of tropical cyclones over the Bay of Bengal around November in the previous 122 years has led to an increase in post-monsoon rainfall over Kerala. The post-monsoon cyclone season is responsible for a sizable portion of the season's rainfall, and the impact of the Bay of Bengal is a distinctive climatic feature over the southern peninsula.Overall, the study highlights the complex and interrelated factors that contribute to changes in rainfall patterns over Kerala, including natural climate variability and human activities. The findings of this study could be useful for policymakers and planners to develop strategies to mitigate the impacts of these changes and adapt to the changing climate conditions.

The paper examines the relationship between temperature, rainfall, and economic growth in Africa. **Matteo Lanzafame**uses an econometric approach based on a reduced-form model, which takes into account parameter heterogeneity and cross-sectional dependence. The study finds that temperature has a clear and significant negative impact on per capita GDP growth in both the short and long run, while the effect of rainfall is less important and statistically less significant. These findings are consistent even when the analysis is focused solely on Sub-Saharan African countries or when considering GDP growth per worker.

The study's results are in contrast to those obtained through standard panel estimators, which do not control for cross-sectional dependence and, therefore, may provide misleading inferences. The study highlights the importance of further research to identify the causal mechanisms linking growth to temperature and rainfall in Africa. The study concludes that African economies appear to be significantly damaged by weather shocks and that corrective measures are needed to address the challenges posed by climate change.

However, the authors acknowledge that their empirical approach cannot be used alone to provide accurate forecasts of the impact of future climate change. More research is needed to identify the most important causal mechanisms linking climate change and economic growth in Africa, and to develop effective policies to address the challenges posed by climate change in the region.

Conclusion

Rainfall and their trend analysis can be performed using various statistical tests, depending on the research question, natureand availability of the data set. Some of the commonly used tests are:*Mann-Kendall Test*: The Mann-Kendall test is a non-parametric test used to analyse the trend in a time series. It is used to test whether there is a monotonic upward or downward trend in the data.

Sen's Slope Estimator: Sen's slope estimator is another non-parametric test used to estimate the trend in a time series. It is used to calculate the slope of the line that best fits the data.*Linear Regression*: Linear regression is a parametric test used to analyse the relationship between two variables. It is used to determine the slope of the line that best fits the data.

Spearman's Rank Correlation: Spearman's rank correlation is a non-parametric test used to determine the strength and direction of the relationship between two variables. It is used to test for a monotonic relationship between two variables.*Pearson's Correlation Coefficient*: Pearson's correlation coefficient is a parametric test used to determine the strength and direction of the relationship between two variables. It is used to test for a linear relationship between two variables.

In addition to these tests, other statistical tools such as time series analysis, frequency analysis and regression analysis can also be used to study and analyse the trends in the rainfall pattern..It is important to note that the choice of statistical test depends on the type of data, the research question, and

the level of analysis required. It is always advisable to consult a statistician or an expert in the field to select an appropriate statistical test.

Rainfall studies are scientific investigations that explore various aspects of rainfall patterns and their effects on different systems. These studies may focus on a specific region, a particular type of precipitation, or a particular time period. Some of the key findings and conclusions that can be drawn from rainfall studies include:

Climate change is affecting rainfall patterns: Many studies have found that global warming is altering rainfall patterns in various parts of the world. In some areas, rainfall is becoming more intense and frequent, while in other areas, it is becoming less frequent and more erratic. Climate models predict that these trends will continue in the coming decades. Extreme rainfall events are becoming more common in recent years and days(Bengalure-2022, Uttarahand, Assam, Himachalpradesh, Delbi, Mumbai, Uttarpradessh 2022,2023), not only in India also globally as well

: Studies have found that extreme rainfall events, such as heavy downpours and floods, are becoming more frequent in many regions. This trend is linked to climate change and can have significant impacts on ecosystems, infrastructure, and human communities.Rainfall is a critical factor for agriculture: Rainfall is essential for crop growth and yields, and studies have shown that changes in rainfall patterns can have significant effects on agricultural productivity. For example, prolonged droughts can lead to crop failures and food shortages, while excessive rainfall can cause flooding and soil erosion.Rainfall is linked to water availability: Rainfall is a key factor in determining water availability for both humans and ecosystems. Studies have found that changes in rainfall patterns can lead to water scarcity, which can have significant social and economic consequences.

Urbanization affects and radically alter rainfall patterns by changing the surface characteristics of landscapes, such as by replacing vegetation with pavement and buildings. This can lead to more runoff and flooding in urban areas, as well as changes in the timing and intensity of rainfall. Overall, rainfall studies provides some of the essential insights into the complex interactions between climate, ecosystems, and human systems, and can inform policies and practices aimed at mitigating the impacts of climate change and ensuring sustainable water management, also it is clear that action is required from all quarters to create sustainable future for the present and future generations.

References:

1. **Matteo Lanzafame (2011):** Temperature, rainfall and economic growth in Africa, received: 1 May 2011 / Accepted: 12 September 2012© Springer-Verlag Berlin Heidelberg 2012.
2. **M. Gilmont a, J.W. Hall a, D. Grey b, S.J. Dadson b, S. Abele b, M. Simp (2018):**Analysis of the relationship between rainfall and economic growth in Indian states Global Environmental Change, Volume 49, March 2018, Pages 56-72, Elsevier.
3. **K.N Krishnakumar*, G.S.L.H.V. PrasadaRao, C.S Gopakumar(2009):** Rainfall trends in twentieth century over Kerala, India, Dept. of Agricultural Meteorology, College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur-680 656, Kerala, India, Atmospheric Environment 43 (2009) 1940–1944.
4. **Hadi Sanikhani1 &Ozgur Kisi2 &Rasoul Mirabbasi3 &SaritaGajbhiye Meshram4 Ifeka A, Akinbobola A (2015):** Trend analysis of precipitation in someselected stations in Anambra State. AtmosClimSci 5:1–12

5. **Koteswaram, P., Alvi, S.M.A., (1969)**. Secular trends and periodicities in rainfall at westcoast stations in India. Current Science 101, 371–375.
6. **Kumar, V., Jain, S. K. & Singh, Y.(2010):** Analysis of long-term rainfall trends in India. Hydrological Sciences Journal–Journal des SciencesHydrologiques 55(4), 484–496 (2010).Mausam 42, 333–338.
7. **Parthasarathy, B., Munot, A.A., Kothawale, D.R., 1995**. Monthly and Seasonal Rainfall. Series for All India Homogeneous Regions and Meteorological Sub-divisions:1871–1994. IITM, Pune, India, Research Report No. RR-065, p. 113.
8. **Pramanik, S.K., Jagannathan, P., 1954**. Climate change in India – 1: rainfall. Indian rainfall over India. Monthly Weather Review101: 371–375.
9. **Rupa Kumar K, Pant GB, Parthasarathy B, Sontakke NA. 1992**.Saudi Society for Geosciences 2018. Arabian Journal of Geosciences (2018) 11:437Sciences (Earth Planetary Sciences)93: 371–385.
10. **Thapliyal, V., Kulshrestha, S.M., 1991**. Climate changes and trends over India. Trend analysis of rainfall pattern over the Central India.