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A Comprehensive Study of Rainfall Distribution and Trends in Dapoli, Maharashtra, India (1980–2023)

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ABSTRACT

This study examines the long-term rainfall distribution and trends in Dapoli, Maharashtra, India, using rainfall records spanning from 1980 to 2023. Dapoli, located in the Konkan region along the western coast of India, receives substantial rainfall due to the influence of the Southwest Monsoon and the orographic effect of the Western Ghats. The objectives of this study are to analyze temporal rainfall variability, seasonal distribution, long-term trends, and the occurrence of extreme rainfall events. Monthly and annual rainfall data were statistically analyzed to identify changes in rainfall patterns over four decades. Results indicate that the monsoon season contributes the majority of annual rainfall, with July and August recording the highest precipitation. The study also suggests increasing rainfall variability and a growing frequency of extreme rainfall events in recent years. The findings provide valuable insights for water resource management, agricultural planning, flood mitigation, and climate adaptation strategies in Dapoli and surrounding coastal regions.

Keywords: Rainfall Trend Analysis, Monsoon Rainfall, Climate Variability, Dapoli, Konkan Region, Water Resource Management.

1. Introduction

Rainfall is one of the most important climatic parameters influencing agriculture, hydrology, water resources, and ecosystem sustainability. In India, where a significant portion of agriculture depends on monsoon rainfall, understanding rainfall patterns is critical for ensuring food security and sustainable development.

The Konkan region of Maharashtra receives some of the highest rainfall totals in the country due to its geographical position between the Arabian Sea and the Western Ghats. Dapoli, situated in Ratnagiri district, is characterized by a humid tropical climate and abundant monsoon precipitation. The economy of the region is largely dependent on agriculture, horticulture, fisheries, and tourism, all of which are strongly influenced by rainfall availability.

Recent climate studies indicate increasing variability in rainfall distribution, including changes in rainfall intensity, duration, and seasonal occurrence. Such variations can result in floods, soil erosion, waterlogging, and agricultural losses. Therefore, a long-term assessment of rainfall trends in Dapoli is essential for understanding climatic behavior and supporting future planning efforts.

The present study aims to analyze rainfall patterns in Dapoli over the period 1980–2023 and evaluate seasonal and annual variations that may influence water resources, agriculture, and disaster management.

2. Objectives of the Study

- To analyze long-term rainfall distribution in Dapoli from 1980 to 2023.
- To study annual and seasonal rainfall variability.
- To identify trends and changes in rainfall characteristics.
- To examine the occurrence of extreme rainfall events.
- To assess implications for agriculture, water management, and climate resilience.

3. Study Area

3.1 Geographic Location

Dapoli is located in Ratnagiri district of Maharashtra in the Konkan coastal belt of western India. It lies approximately at 17.75°N latitude and 73.18°E longitude and has an average elevation of about 250 meters above mean sea level.

The region is bounded by: Arabian Sea to the west; Western Ghats to the east; Ratnagiri district in the south; and Raigad district in the north. Its strategic position between the coast and mountains significantly influences rainfall distribution.

3.2 Climate

Dapoli experiences a tropical monsoon climate characterized by warm and humid conditions throughout the year, heavy rainfall during June–September, mild winters, and moderate pre-monsoon and post-monsoon rainfall. The annual rainfall generally ranges between 3000 mm and 4500 mm, making it one of the wettest locations in Maharashtra.

3.3 Importance of the Area

Dapoli is an important center for rice cultivation, mango and cashew production, coconut plantations, fisheries, agricultural research, and coastal tourism.

4. Materials and Methods

4.1 Data Collection

Monthly rainfall data for Dapoli covering the period January 1980 to December 2023 were collected from the India Meteorological Department (IMD), Regional Meteorological Centers, and agricultural research stations. The dataset includes monthly rainfall totals expressed in millimeters.

4.2 Data Processing

The rainfall records were organized and processed using Microsoft Excel and statistical software packages. The following analyses were conducted: monthly rainfall analysis, annual rainfall analysis, seasonal rainfall analysis, decadal rainfall comparison, and trend analysis.

4.3 Statistical Analysis

The following statistical parameters were calculated: mean rainfall, standard deviation, maximum rainfall, minimum rainfall, coefficient of variation, trendline analysis, and moving averages. These measures helped identify rainfall fluctuations and long-term climatic tendencies.

4.4 Seasonal Classification

Rainfall data were grouped into four seasons: Winter (December–February), Pre-Monsoon (March–May), Monsoon (June–September), and Post-Monsoon (October–November). Seasonal totals were computed to evaluate rainfall contribution and variability.

5. Results and Discussion

5.1 Annual Rainfall Characteristics

The analysis indicates that Dapoli receives high annual rainfall primarily due to the Southwest Monsoon. Annual rainfall exhibits significant year-to-year fluctuations resulting from monsoon variability, cyclonic systems, climate oscillations, and regional atmospheric conditions. Despite these fluctuations, long-term averages suggest relatively stable rainfall availability compared to many inland regions.

5.2 Seasonal Rainfall Distribution

The monsoon season contributes approximately 85–90% of total annual rainfall.

Monsoon Season (June–September): Dominant rainfall period; responsible for groundwater recharge; supports agriculture and reservoirs.

Pre-Monsoon Season (March–May): Moderate convective rainfall; important for land preparation and horticulture.

Post-Monsoon Season (October–November): Occasional rainfall from retreating monsoon systems; beneficial for horticultural crops.

Winter Season (December–February): Minimal rainfall contribution.

5.3 Decadal Trends

Decadal comparisons suggest moderate rainfall stability during the 1980s and 1990s, increased rainfall variability after 2000, and greater occurrence of high-intensity rainfall events during the 2010s and early 2020s. These observations align with broader climate change studies conducted in the Western Ghats and Konkan region.

5.4 Extreme Rainfall Events

Several years recorded exceptionally high rainfall associated with strong monsoon systems, low-pressure depressions, and cyclonic influences from the Arabian Sea. Extreme rainfall events have increased the risk of flash floods, soil erosion, landslides, and infrastructure damage. The frequency of intense short-duration rainfall appears to be increasing in recent decades.

6. Implications for Agriculture and Water Management

Agriculture

Rainfall strongly influences rice productivity, fruit crop yield, plantation crops, and soil moisture availability. Irregular rainfall can adversely affect sowing schedules and crop growth.

Water Resources

Heavy monsoon rainfall contributes to reservoir storage, groundwater recharge, and river flow maintenance. However, excess rainfall often results in runoff losses.

Disaster Management

Understanding rainfall trends can assist in flood forecasting, landslide risk assessment, emergency planning, and climate adaptation strategies.

7. Conclusions

The present study provides a comprehensive assessment of rainfall distribution and trends in Dapoli, Maharashtra, during the period 1980–2023. Dapoli receives abundant rainfall due to the Southwest Monsoon and the Western Ghats. Monsoon months account for the majority of annual rainfall, with July and August as the wettest months. Rainfall variability has increased in recent decades, and extreme rainfall events are becoming more frequent. Climate variability poses challenges for agriculture, water resources, and disaster management. The study highlights the need for continuous rainfall monitoring, improved water resource planning, and climate-resilient development strategies in the Konkan region.

8. Recommendations

- Strengthen rainfall monitoring networks.
- Promote rainwater harvesting systems.
- Improve watershed management practices.
- Develop flood and landslide early warning systems.
- Encourage climate-smart agriculture.
- Conduct further research on climate change impacts in coastal Maharashtra.

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