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COMPREHENSIVE ANALYSIS OF RAINFALL PROBABILITY IN PUNE DISTRICT, MAHARASHTRA

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Abstract:

Rainfall is the most effective and powerful component of our natural environment. These components have a complex bearing on the formation of soil, natural vegetation, different flora and fauna, biodiversity, and, ultimately, various economic activities and occupations of human beings. In this research work, an attempt is made to show how rainfall affects the various economic activities of a human being. The rainfall of the region plays an integral part in our natural environment. These elements influence the people's way of life in a particular region. Even the land's surface is primarily modified by the action of rainfall. In agricultural activity, planting crops requires an intelligent use of information about rainfall regarding the length and characteristics of the growing season.

Thus, the available rainfall data are essential in agricultural activity, natural vegetation, biodiversity in flora and fauna, soil types, and climatic changes in the region. The analysis of rainfall explains the causal relationship between climate and human activity, which serves the primary purpose of this work. This research article thoroughly investigates the climatic dynamics of Pune District, Maharashtra, focusing on the analysis of historical data related to rainfall and the probability estimation of rainfall. The study aims to contribute valuable insights into the spatiotemporal patterns of these meteorological variables, providing a basis for informed decision-making in sectors such as agriculture and water resource management.

Keywords: Analysis, Rainfall, Trends, Methodology, Probability Estimation

I. Introduction:

A trend of about 10 to 12 percent (of the normal) increase in monsoon rains was reported along the west coast, northern Andhra Pradesh, and northwestern India during the last century. A decreasing trend of about 6 to 8 % has been observed over the last 100 years in eastern Madhya

Pradesh, North-Eastern India, and some parts of Gujarat and Kerala (Mall, 2006). Huge crop losses were noticed in Maharashtra (India) due to unseasonal and poor rainfall distribution during 1997-98. The 1997/1998 El Nino event affected 110 million people and resulted in the loss of nearly US$ 100 billion of the global economy. Insurance companies showed that natural weather-related catastrophes caused an estimated economic loss of US$960 billion for the period of 1950-1999 (IPCC, 2007). Apple productivity in particulars and stone and other fruit, in general, has shown a declining trend of 40-50 percent in Himachal Pradesh up to 1500 mm due to warmer climate and lack of chilling required chilling hours during winter and adequate growth during warmer summers (Petri & Leite, 2004). The apple-growing area is rapidly shifting from lower elevations to higher elevations, and larger areas have been reduced unfit for cultivation (Rana et al., 2008).

The rain and hails during flowering adversely affect the fruit set, whereas a moderate temperature of 20 with relatively low rains during flowering results in a good fruit set (Randev, 2009). Rana and others (2009) reported a decrease in chill unit hours in the apple-growing areas of Himachal Pradesh. Most of the apple varieties require 1000-1600 hours (at or below 7.2^0C) of chill units, depending upon the variety (Singh & Sharma, 2015).

Pune District, with its diverse topography, is subject to varying climatic conditions. Understanding the intricate relationships between rainfall, temperature, and the Probability of weekly rainfall is essential for adapting to climate change and fostering sustainable development in the region.

1.1 Location of Study Area

The city ‘Pune’ is in the tropics at more than 550 mm, above sea level. Its latitudinal extension is 18 31' north and 7351' east. The town is 30 miles from the crest line of the Sahyadri and 63 miles from the Arabian Sea. It has a strategic position in the valley of Mula-Mutha, which joins each other a few kilometers east of Pune and forms a part of the Bhima basin and a part of the Krishna basin. Pune is situated on the lee-word side of the western Ghats and the western margin of the Deccan plateau. The general slope of the area is towards the east. The terraces become broader and more extensive down the valley to the east.

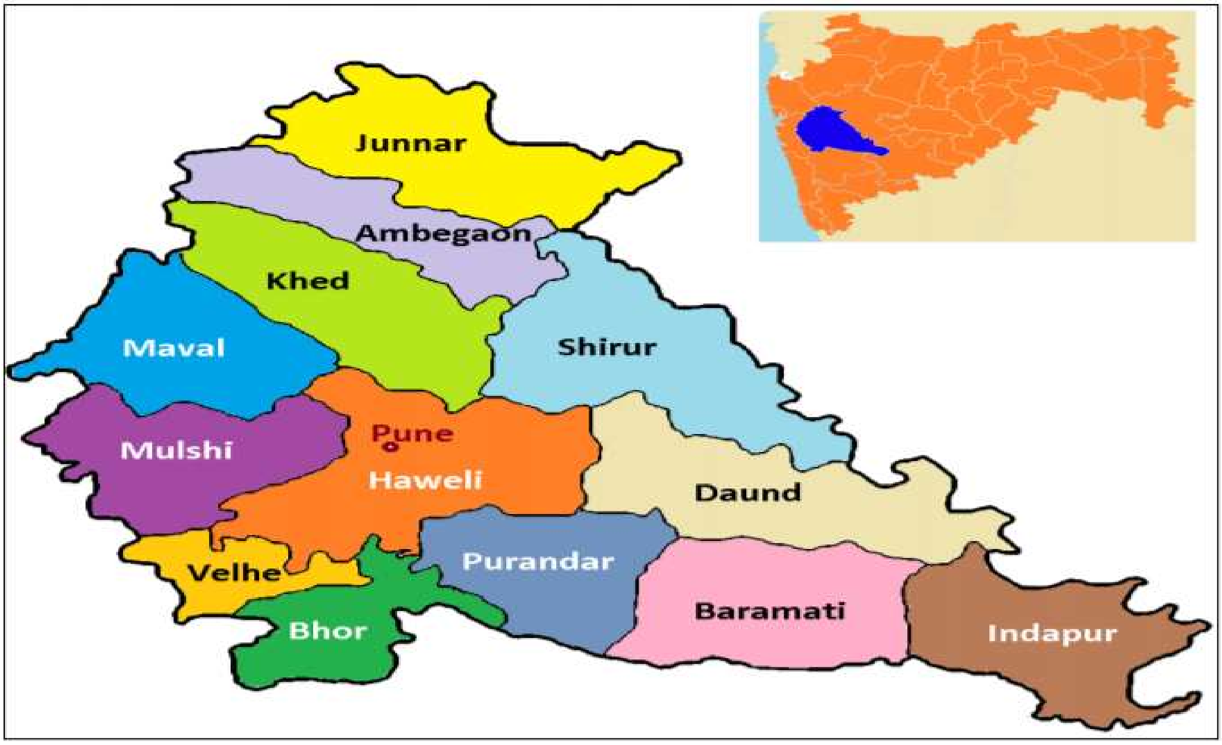

Fig.1.1: Presentation of the investigation area of the location map of Pune

Objectives of the Present Study Aims to Analyze Rainfall and Probability Estimation of Weekly Rainfall Data of Pune District.

II. Material and Methodology:

The study investigates temporal variations in rainfall patterns, emphasizing seasonal changes and long-term trends. Special attention is given to monsoon seasons, which are critical for the regional climate. The entire study is based on secondary data pertaining to the rainfall of Pune city. The hundred years of data on precipitation and temperature of Pune city (From 1901 to 2000) is collected from the Indian Meteorological Department, which is in the central part of the city. Primary data is collected through intensive fieldwork. Some secondary data has been collected from the District Gazetteer, Municipal yearbook, District statistical abstract Soc, economic abstract, and records of villages, tahsils, and Panchayat offices.

The main objective of the study is to analyze rainfall and probability estimates of the data of the Pune district. Temporal variation in rainfall is very high in Pune. These variations in rainfall on an annual, monthly, and weekly are studied using the rainfall data of Pune station during the 100 years from 1901 to 2000. Using the rainfalldata, various analyses, such as mean, mode, median, variability, standard deviation, and co-relation, have been drawn. Probability estimates have been drawn using the rainfall data. The weekly rainfall data can be characterized in two ways.

1) Constant rainfall analysis

2) Constant probability analysis

In this study, an attempt is made to analyze the constant rainfall analysis. It deals with the Probability of occurrence of a specified minimum amount of rainfall. This can be analyzed using Markov Chains' first-order probability model. Gabriel and Neumann 1962 by computing constant rainfall analysis on a weekly basis. In this project, rainfall probabilities are studied in three ways.

1) Initial probabilities of wet week [p(w)]

$$Pw = \frac{\text{No. of weeks having more than 10mm of rainfall}}{\text{Total no. of weeks}}$$

2) Conditional Probability of a given wet to be followed by wet week [p(w/w)]

$$P(w/w) = \frac{N(WiWj)}{N(Wi)}$$

N (WiWj)= Number of occurrences of wet week in I & j period.

N(Wi)= Number of occurrences of a wet week in the I & j period.

3) Conditional probabilities of a given dry followed by a wet week [P(WdWj)]

$$P(WdWj) = \frac{N(WdWj)}{N(Wd)}$$

N(WdWj)= Number of occurrences of a dry week in the I and j period.

N(Wd)= Number of occurrences of dry week in I period.

III] Result and Discussion:

The study undertaken in this project is to analyze the rainfall and probability estimates of weekly rainfall in the Pune district. Spatial Distribution: An assessment of the spatial distribution of rainfall across different regions within the Pune District provides insights into localized climatic variations.Rainfall Probability Estimates Rainfall is analyzed to enhance our understanding of the likelihood of specific rainfall events, aiding in short-term planning and risk assessment.The research integrates rainfall and probability estimates to identify potential correlations and dependencies, offering a holistic understanding of the climatic conditions in the Pune District.

The analysis aids in the effective management of water resources, with a focus on planning and allocation strategies based on rainfall probability estimates. Rainfall data inform urban planning efforts, mitigating challenges such as the urban heat island effect and enhancing overall resilience.

The normal annual rainfall over the district varies from about 500 mm to 4500 mm. It is minimal in the eastern part of the district around Daund (468 mm), Baramati (486 mm), and Jujuri (494 mm). This increases towards the west and reaches a maximum around Khandala (4659 mm) in the western ghat. The chances of receiving normal rainfall are maximum (50 to 55%) in the eastern part around Indapur and Daund, in the central part around Pune city, and in small areas around Junnar in the northern part of the district. The rainfall analysis also indicates drought area in the eastern, southern, southeastern, central, and northwestern parts around Indapur, Baramati, Jujuri, Daund, Talegaon, Dhamdhare, Alandi,Shirur, and Bhor, covering around 50% area of the district.The Chances of receiving normal rainfall are maximum (50 to 55%) in the eastern part around Indapur and Daund, in the central part around Pune city, and in small areas around Junnar in the northern part of the district. Rainfall analysis also indicates the occurrence of drought-prone areas in the eastern, southern, southeastern, central, and northwestern parts around Indapur, Baramati, Jujuri, Daund, Talegaon, Damdhare, Alandi, Shirur, and Bhore, covering about 50% area of the district. Taluka-wise average annual rainfall for the period 2003 to 2012 ranges from about 474 mm (Daund) to 2668 mm (value) (CGWB, 2013).

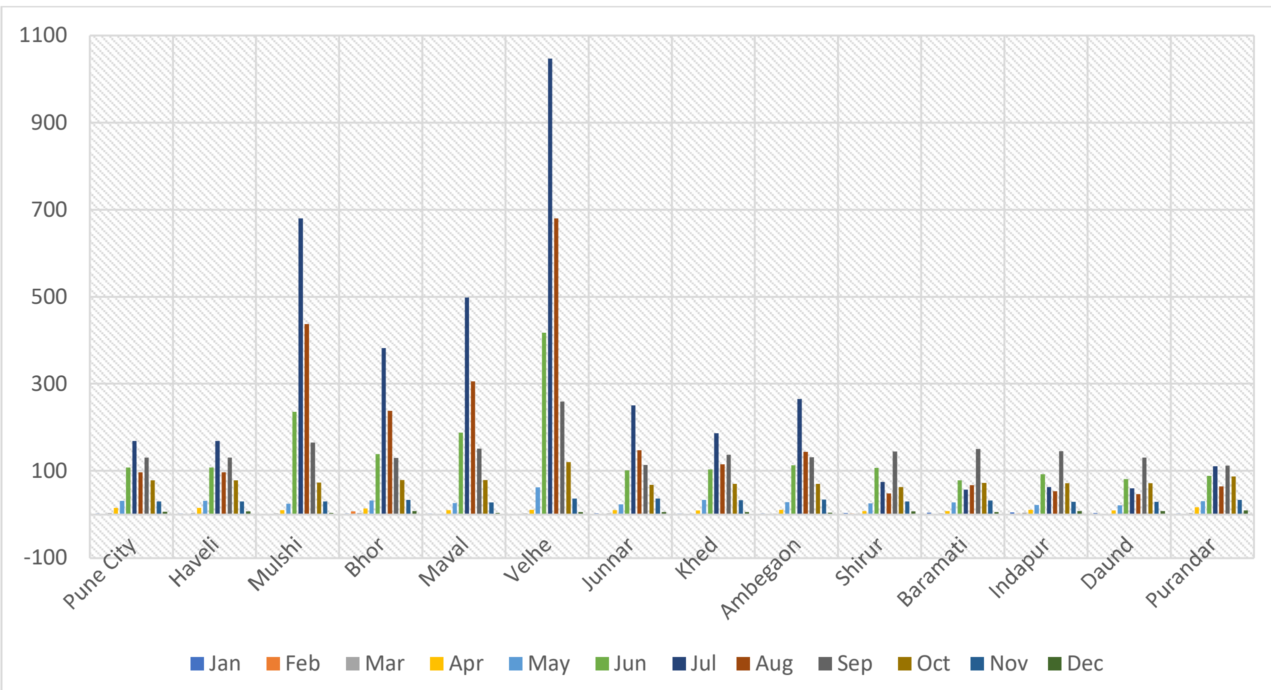

Fig.3.1: Showing the Taluka-wise monthly normal rainfall in mm.

Several research workers (Benson-1924, Jorgenson 1948) pointed out that the observed frequencies of the rain spells of different durations did not agree with those calculated based on climatic Probability. Their conclusion was that the Probability of rainy-day occurrence was not independent of immediate pass conditions, indicating they're by persistence phenomenon in rainfall. Many research workers later fitted different models to the runs of wet and dry spells.

To explain the observed spells of rainy days, Concharan (1938) proposed a probability model based on the theory of rains, and later William (1952), Langley (1953), and Cook (1962) used the Markov Chain probability model to fit the daily rainfall observations.Several workers in India, Raman and Krishnan (1960), Rambhadran (1954), Shrinivasan (1954-59-64), and Basoo (1971), have studied the runs of dry and wet spells for selected stations for rainfall persistence.

Table 3.1 shows the Taluka's monthly average rainfall in mm.

Taluka	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pune City	2.0	0.9	3.3	14.9	31.5	107.4	168.9	96.5	130.1	78	29.9	6
Haveli	2.0	0.9	3.3	14.9	31.5	107.4	168.9	96.5	130.1	78	29.9	6.6
Mulshi	1.2	0.5	2.7	10.1	24.3	235.3	680.1	437.3	164.7	73.4	29.8	3.3
Bhor	1.7	6.7	3.0	13.7	31.9	138.9	381.7	237.7	129.6	79.3	33.6	7.4
Maval	1.4	0.6	1.3	9.9	25.8	187.6	498.4	305.8	151.3	79	27.8	3.4
Velhe	0.1	0.1	2.5	10.7	62.3	417.2	1047	679.9	258.8	120.4	36.3	5.7
Junnar	2.2	1.1	2.6	9.7	22.9	100.9	250.6	147.5	113.3	68.3	36.1	5.7
Khed	1.8	0.8	1.9	8.8	33.2	103.4	186.4	114.7	136.8	70.1	32.8	5.1
Ambegaon	1.9	0.2	2.1	10.8	28.4	112.7	265.3	143.7	131.3	70	34.3	3.9
Shirur	3.0	2.1	1.7	7.5	25.1	106.9	74.4	48.3	144.5	62.9	30	7.2
Baramati	4.2	0.8	2.2	7.7	27.7	78.5	56.7	67.4	150.1	72.2	32.1	5.3
Indapur	4.9	1.5	3.6	10.3	21.9	92.2	63	53.1	145.3	71.7	28.7	7.6
Daund	3.0	0.9	1.0	9.0	20.7	81.5	60.2	46.7	130.7	71.3	29.1	7.4
Purandar	1.4	0.6	3.0	16.2	30.4	88.7	110.7	64	112	87.2	33.1	9.1

Source: www.agri.mah.nic.in

IV. Conclusion:

This research provides a comprehensive analysis of rainfall and probability estimations of rainfall in the Pune District. They observed the overall Impact of the rain and its correlation to indirect or direct effects on agriculture and plant production in the surrounding areas, too. The findings offer valuable insights for policymakers, researchers, and stakeholders, facilitating evidence-based decision-making and sustainable development practices in the face of climate variability.

Recommendations for Future Research:

Invest in advanced climate modeling techniques to improve the accuracy of long-term predictions and enhance our understanding of complex climatic interactions. Develop systems for real-time monitoring of meteorological parameters to facilitate adaptive responses to sudden changes in climatic conditions. Engage local communities in climate resilience initiatives, leveraging the research findings to enhance adaptive capacities at the grassroots level.

Declaration: The authors of this manuscript do not oppose the interest.

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