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## Land and water resource inventory and planning for sustainable agriculture in selected area of Belagavi district, Karnataka

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### Abstract

Rainfall is a volatile and fragile resource that is vital for the success of dryland agricultural production systems. To support the development of rainfall-based farming strategies, the probability and variability of daily rainfall data recorded from 2005 to 2019 in Masarguppi (Athani), located in the Belgaum Northern region of Karnataka, India, were analysed. Rainfall, being a critical natural input for rainfed cropping systems and characterized by high uncertainty and cyclical behaviour, was examined in detail. Statistical analyses were conducted to compute annual, seasonal, monthly and weekly averages along with standard deviations and coefficients of variation. Additionally, rainfall probability was evaluated using the Markov Chain approach. The annual precipitation ranged between 356.1 and 790.7 millimetres, with the highest rainfall recorded in 2019 (790.7 mm) and the lowest in 2012 (356.1 mm). Based on 50, 60 and 70 percent probability levels, a total of 16 weeks (from the 25th to the 41st week) were identified as suitable for kharif crop cultivation under rainfed conditions. Further, initial and conditional probability analysis for 20 mm rainfall indicated that dry spells generally preceded the onset of monsoon weeks. Assessment of the 15-year dataset revealed that meteorological drought conditions occurred during 46 percent of the study period, predominantly classified as mild to moderate.

**Keywords:** Rainfall, probability analysis, trend analysis, crop planning, seasonal rainfall, rainfed agriculture

### Introduction

Rainfall is a key determinant in crop production planning, particularly in regions that depend on rainfed agriculture. Information regarding annual, seasonal, monthly and weekly rainfall is vital for scheduling agricultural practices and ensuring optimal crop performance. In India, approximately 60 percent of agricultural production depends on rainfall, and the farming systems are often diverse and highly complex. The productivity of these systems is further affected by high variability and an increasing frequency of extreme weather events such as heavy rainfall, prolonged dry spells and droughts.

The success or failure of crops grown under rainfed conditions is closely associated with the distribution and timing of rainfall (Khichar *et al.*, 1991) [22]. Although India receives substantial rainfall each year through four major weather systems namely the South West monsoon, North East monsoon, winter and summer rainfall periods, the spatial and temporal variability poses major challenges. This uncertainty often restricts the effective duration of the crop growing period and may also increase the risk of flood events. Since rainfall acts as one of the most crucial natural resources for sustaining agriculture, its distribution throughout the year is essential for determining cropping patterns and planning irrigation schedules. Engineers also utilize rainfall intensity and distribution data for designing water conservation and irrigation structures.

Variability in rainfall significantly affects agricultural sustainability and productivity, particularly in tropical environments. Assessing rainfall variability helps in formulating effective agricultural strategies. Pre monsoon showers facilitate land preparation and contribute to timely sowing of kharif crops.

The success of rainfed agriculture largely depends on the onset and withdrawal of monsoon rains. A delay in monsoon onset adversely affects crop sowing and may result in reduced yield, while early cessation of rainfall can lead to severe moisture stress during critical physiological stages such as grain formation and development (Dixit *et al.*, 2005) [14].

An important component of crop planning involves assessing both backward and forward rainfall accumulation to determine the start and end of the wet season using precipitation data. Farmers generally begin sowing operations when sufficient rainfall has adequately moistened the surface soil layer.

It is well established that crop growth is adversely impacted if dry periods coincide with sensitive or critical growth stages. Conversely, dry conditions during the crop ripening phase may sometimes prove beneficial. Therefore, understanding the pattern and sequence of wet and dry periods is essential for effective agricultural planning.

To sustain crop production in rainfed areas, it is necessary to design farming systems that maximize the use of rainfall potential. Since rainfall is highly erratic across both spatial and temporal scales, probability analysis provides an improved approach for estimating minimum assured rainfall. The normal probability distribution is commonly used as a theoretical model for analyzing observed precipitation data Panigrahi and Panda, 2002 [34].

Recognizing the above concerns and realizing that, this study has been undertaken with the following objectives:

- Analysis of rainfall pattern at the study area.
- Meteorological drought characterization and analysis of dry and wet spells.
- Resource planning in agriculture.

## 2. Methodology

### 2.1 Location and General Features of the Study Area

Masarguppi village is located in Athani Taluk of Belagavi

district in northern Karnataka, positioned at 16°45'51'' N latitude and 74°59'56'' E longitude, covering a geographical area of 806.17 hectares. The village is bordered primarily by Madhabhavi village and other parts of Athani Taluk. Figure 1 illustrates the locations of the stations selected for the purpose of this study.

Situated in the elevated terrain of the north-western region of Karnataka, Masarguppi (Athani) experiences a tropical climate with moderately stable weather conditions throughout the year. The region receives rainfall from both the South West and North East monsoon systems, with most of the precipitation occurring between June and September. Although climatic conditions vary seasonally, extreme weather events are uncommon. The coldest month is typically December, with an average minimum temperature of around 25.3 °C, while May is the hottest month, with average maximum temperatures reaching up to 40 °C. Winter temperatures rarely fall below 18 °C, and summer temperatures generally remain within the range of 30 to 40 °C. January is the driest month, receiving approximately 10 mm of rainfall.

Athani Taluk, the largest in Belagavi district, extends over 2070.54 km<sup>2</sup>, of which nearly 74 percent is under cultivation. The Taluk includes 115 inhabited villages and hamlets, with a rural population of 407,485 as recorded in the 2011 census. The total population of Athani Taluk is 525,832. It is bound by Sangli district in Maharashtra to the north, Vijayapura district to the east and the Krishna River to the south, which flows approximately 110 km through the region. Geologically, the area is characterised by the Deccan Trap formation. The average annual rainfall for the Taluk is around 582 mm. Two major rivers flow through this region, namely the Krishna and Agrani Rivers, with the Agrani River passing through areas such as Pandegao, Shirur, Ajur, Sambargi, Nagnur (P.A), Tawanshi and Kalloti.

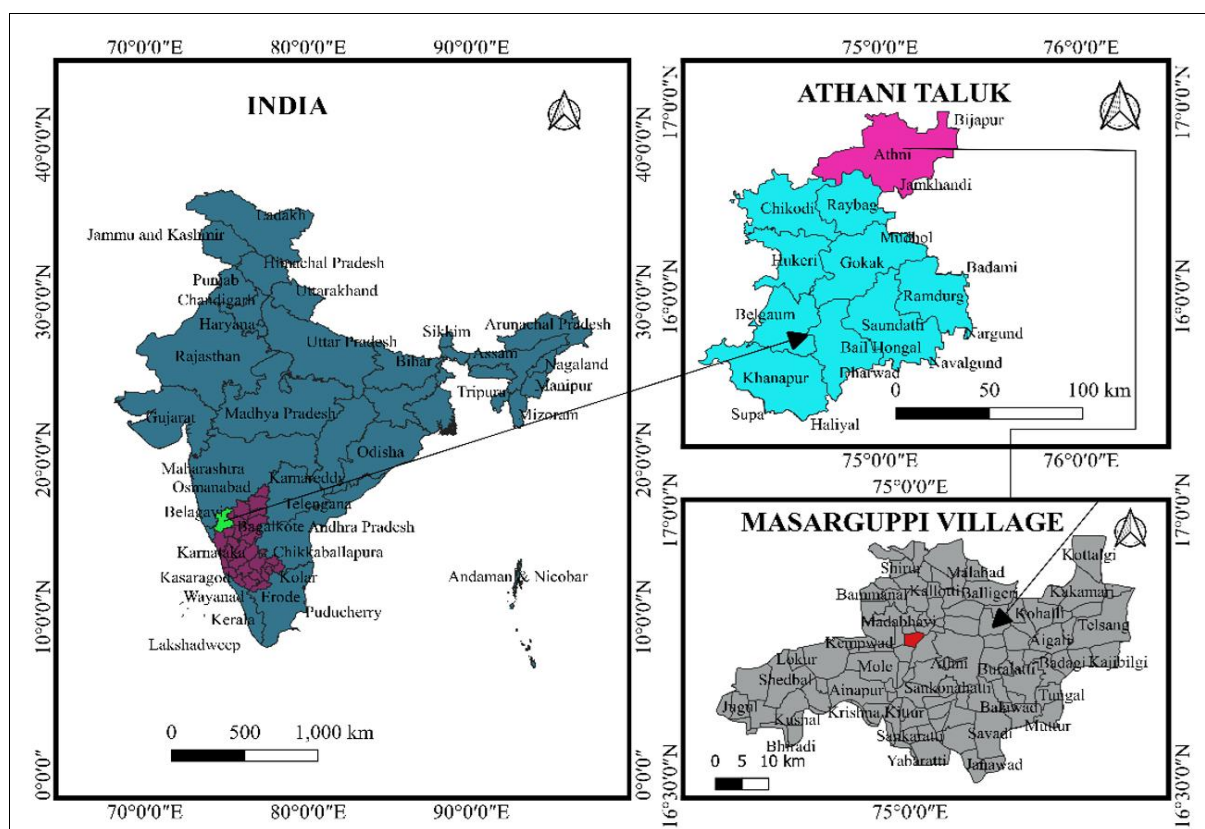


Fig 1: Location of the Selected Station for Study.

### 2.1.1 Agriculture

Agriculture is the primary occupation in Athani Taluk, with approximately 60 percent of the population engaged in farming activities. The major *kharif* crops cultivated in the region include jowar, maize, cotton and vegetables, while during the *rabi* season, maize, jowar, groundnut and sunflower are predominantly grown. Sugarcane, being a perennial and commercially significant crop, occupies around 37 percent of the total cultivated area, making Athani one of the leading sugarcane-producing taluks in Karnataka. Maize accounts for about 19 percent of the total crop area of the Taluk.

The net sown area represents about 55 percent of the total geographical area, whereas 43 percent of the land is cultivated more than once annually. Irrigation sources in the Taluk include canals (3 percent), dug wells (17 percent) and bore wells (18 percent) of the total net irrigated area. Despite limited rainfall, farmers often employ diesel-powered pump sets for irrigation where groundwater or surface water is available.

Sugarcane, jowar and wheat are the major crops cultivated, while grapes and groundnut constitute significant commercial crops. A variety of vegetables such as tomato, brinjal, okra, leafy greens and red chilli are also cultivated. Approximately 70 percent of the agricultural land in the Taluk is considered fertile. The proximity to the Krishna and Agrani rivers favours large-scale sugarcane cultivation across more than 150,000 acres. Further support to irrigation is provided through the canals constructed under the Hipparagi Barrage of the Upper Krishna Project, which substantially benefits the cultivation of sugarcane and grapes. As a result, sugarcane and jowar are extensively cultivated by farmers in the region.

### 2.1.2 Soil

The dominant soil type in Athani Taluk is mixed sandy soil, followed by black soil in certain areas. The mixed sandy soil category primarily includes brown loam, brown sandy soil, sandy loam and medium black soil textures.

### 2.1.3 Rainfall Data

Athani Taluk experiences a semi-arid climate, with hot and dry weather prevailing for most of the year. It falls under the Northern Dry Agro-Climatic Zone of Karnataka and is classified as drought-prone (Patil & Dholakia, 2018) <sup>[37]</sup>. The average annual rainfall recorded for the study period (2005-2019) is approximately 574 mm. The local climate remains relatively moderate without extreme fluctuations. The annual weather cycle is typically categorised into four distinct seasons: summer (March-May), south-west monsoon/rainy season (June-September), post-monsoon season (October-November) and winter (December-February) (IMD, 2021).

Rainfall data were obtained from a single rain gauge station located within Athani Taluk. The long-term record maintained at this station is considered reliable and representative of the region's rainfall characteristics, and hence was used for analysis in the present study.

### 2.2 Collection and Compilation of Data

Daily rainfall data for this study were sourced from the Hipparagi Barrage Committee station for the period 2005-2019. The dataset was collected in its original form to meet the study objectives. Rainfall analysis was carried out at different temporal scales, which included:

1. Daily rainfall analysis
2. Weekly analysis based on standard meteorological weeks
3. Seasonal rainfall analysis
4. Monthly rainfall analysis
5. Annual rainfall analysis

### 2.3 Statistical Analysis of Rainfall

The statistical characteristics of hydrological data are typically assessed using parameters such as mean, standard deviation, coefficient of variation and skewness, which are indicators of variability. In the present study, these parameters were computed to analyse rainfall variation on annual, seasonal, monthly and weekly bases. Statistical processing was performed for the available datasets to understand rainfall distribution and variability across different time scales.



Fig 2: Showing Farm Pond and Salt affected area near stream at the study area

## 3. Results and Discussion

Crop productivity in dryland agricultural systems is predominantly influenced by climatic conditions. Under rainfed conditions, water availability is limited, therefore it is essential to use the available rainfall resources judiciously to optimise crop yield. Since rainfall is the primary source of water for such regions, a comprehensive and quantitative understanding of its

temporal and spatial variability is crucial for effective agricultural planning and decision-making.

### 3.1 Data collection

The study was conducted with the aim of assessing rainfall characteristics using data recorded at the HBC rain gauge station. Daily rainfall data for a period of fifteen years, from

2005 to 2019, were obtained from available records and utilised for analysis.

Rainfall patterns were evaluated on annual, seasonal, monthly and weekly scales. In addition, probabilities of continuous wet and dry spells were computed. Weekly rainfall occurrences were analysed at different probability levels in order to assess their suitability for crop scheduling. The study was carried out under the prevailing climatic conditions of Belagavi district, and based on the findings, appropriate crop planning strategies were recommended. Two autoregressive models were developed, one to predict weather spells and another to forecast monthly rainfall.

### 3.2 Statistical behaviour of rainfall

To evaluate the statistical nature of the rainfall data, various parameters were computed for daily, weekly and annual rainfall series. Analysis of the daily rainfall series was limited to the monsoon season, which typically occurs from June to September.

The statistical assessment included the computation of the mean, standard deviation and coefficient of variation, using the formulas described in Section 2.3. These parameters were useful in understanding variability in rainfall distribution across different time scales.

#### 3.2.1 Analysis of Daily Rainfall Series.

More than eighty percent of the total annual rainfall in the study area occurs between June and September. Therefore, statistical parameters were estimated for this period only. Based on the analysis of daily rainfall during the monsoon months, it was observed that rainfall variability was highest during the month of July, while relatively lower variability was noted from August onwards. This indicates that during the initial phase of the monsoon, rainfall distribution in both intensity and duration is more erratic compared to the peak monsoon period.

#### 3.2.2 Analysis of Weekly Rainfall Series

The statistical evaluation of weekly rainfall data for all 52 standard weeks is presented in Table 3.5. The analysis indicates that nearly 80 percent of the total annual rainfall occurs during the monsoon period, which spans from the 24th to the 39th standard week. The remaining rainfall is distributed across the pre monsoon period during the 22<sup>nd</sup> and 23<sup>rd</sup> standard weeks and the post monsoon period during the 40th and 41st standard weeks. This clearly shows that rainfall is significantly concentrated within the monsoon season.

#### 3.2.3 Analysis of seasonal rainfall

Seasonal rainfall data was examined to determine its contribution to the annual average rainfall. The analysis was performed for the Kharif period from the 23<sup>rd</sup> to the 39th standard meteorological week, for the Rabi period from the 40th to the 08th standard meteorological week and for the summer period from the 09th to the 22nd standard meteorological week. Findings are reported in Table 1.

The mean rainfall during the Kharif season is 388 millimetres. The Rabi season contributes an average of 74 millimetres, while the summer period which represents the pre monsoon season receives an average of 113 millimetres. The maximum and minimum rainfall values along with the standard deviation and coefficient of variation for each season are also provided in Table 1.

The maximum rainfall observed during the Kharif season was 544.70 millimetres. For the Rabi season, the highest recorded

rainfall was 265 millimetres. The summer season recorded a maximum of 187.70 millimetres. Standard deviation and coefficient of variation values were computed for each season to quantify variability and are presented in the same table.

**Table 1:** Analysis of seasonal rainfall

| Season        | Mean | Max    | Min | SD    | CV (%) |
|---------------|------|--------|-----|-------|--------|
| Kharif season | 388  | 544.70 | 0   | 93.87 | 24.19  |
| Rabi seasonal | 74   | 265    | 0   | 82.58 | 111.82 |
| Summer season | 113  | 187.70 | 0   | 39.98 | 35.42  |

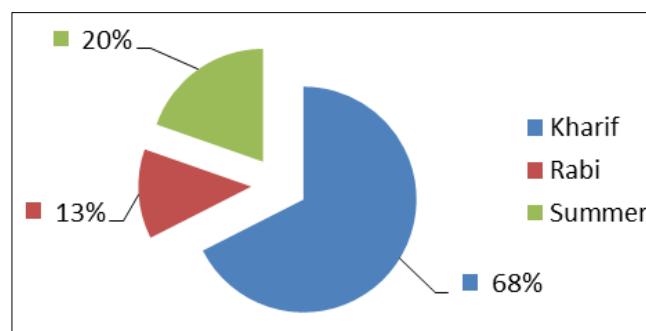


**Fig 3:** Distribution of rainfall over different seasons

#### 3.2.4 Analysis of monthly rainfall

Understanding monthly rainfall variability is essential for effective planning in water resource management and engineering applications. It also helps in identifying suitable regions for rainfed crop cultivation and designing rainwater harvesting strategies during the monsoon season (Ali *et al.*, 2007)<sup>[62]</sup>.

##### 3.2.4.1 Statistical analysis of monthly rainfall

Monthly rainfall observations from the Masarguppi (Athani) station in Belagavi district were evaluated, and the results are presented in Table 4.7. The analysis indicated that September, which marks the end of the North East monsoon period, received the highest average rainfall among all months. August recorded the second-highest monthly rainfall.

The coefficient of variation showed that only the months during the South West monsoon season (June to September) recorded CV values below 100 percent, indicating relatively reliable and consistent rainfall with respect to mean monthly rainfall. From the skewness analysis, all twelve months exhibited positive skewness at the selected station, suggesting rainfall distribution where mean values were greater than the median and mode. Months with skewness values exceeding 3.0 reflected a high degree of variability.

##### 3.2.4.2 Trend of monthly rainfall

Trend analysis of monthly rainfall data was carried out for the period June to November to assess whether rainfall patterns followed an increasing or decreasing trajectory over time at the selected station in Belagavi district. A trend was considered significant when the coefficient of determination ( $R^2$ ) was equal to or above 0.1, corresponding to a reliability of 10 percent. Positive regression slopes indicated increasing rainfall trends, while negative slopes denoted decline. The outcomes showed that most months during the rainy season displayed non-significant decreasing trends. Although statistically non-significant, these decreasing patterns may still indicate a gradual reduction in rainfall during the monsoon months.

### 3.2.5 Analysis of annual rainfall

Figure 4 illustrates the annual rainfall variability from 2005 to 2019. The data reveals a recurring pattern of similar rainfall amounts every 5 to 8 years. The mean annual rainfall during this period was 579.788 mm, with a standard deviation of 142.6097 mm. The analysis indicates relatively minor fluctuations in annual rainfall from year to year, showing stable long-term rainfall performance.

#### 3.2.5.1 Trend analysis of annual rainfall

Trend computation helps determine whether a region is experiencing increasingly wet or dry conditions over time. A positive trend in annual rainfall suggests a shift toward wetter conditions, while a negative trend indicates a possible transition toward dryness. Trend analysis was conducted to evaluate annual rainfall fluctuations using the criterion of  $R^2 \geq 0.1$  (10 percent reliability). Regression slopes were interpreted accordingly, with positive slopes indicating increasing rainfall trends and negative slopes reflecting decreasing trends.

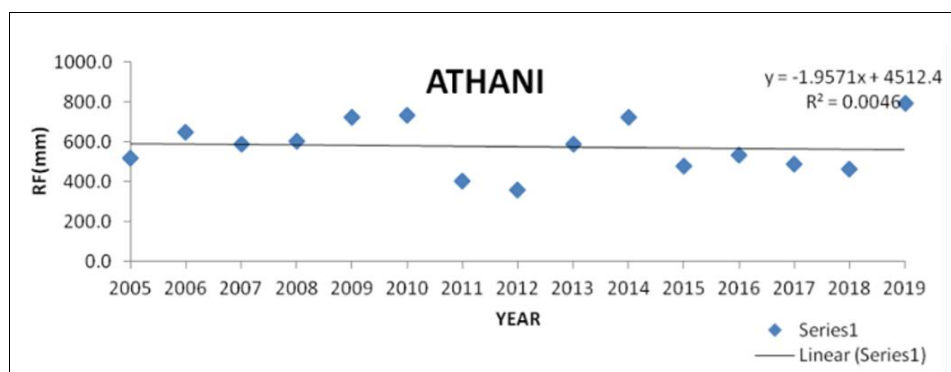


Fig 4: Trend Analysis Distribution of Annual Rainfall (2005-2019) At Masarguppi, Athani

### 3.3 Probability Distribution of Rainfall

The selection of an appropriate distribution for estimating rainfall at various probability levels depends on the specific purpose of the analysis. For agricultural planning, the expected total rainfall during different weeks is required, whereas for hydraulic structure design, focus is generally placed on the annual one day maximum rainfall. To meet these requirements, the recorded rainfall data was converted into weekly, four week block, and annual maximum one day series. Probability analysis was then performed as discussed in section 3.4.

Analysis of the probability values presented in Figures 4.9 to 4.30 indicates a gradual increase in rainfall from the twenty third to the twenty seventh week. A sharp rise is observed during the twenty ninth week, followed by a continued steady increase from the thirtieth to the thirty fourth week. Between the thirty seventh and thirty ninth week, a minor increase is recorded, after which rainfall declines significantly and almost reaches zero beyond the forty second week.

#### 3.3.1 Probability of occurrence of weekly rainfall

A comparative assessment of daily mean rainfall values showed that rainfall variations were nearly similar during the onset and withdrawal phases of the monsoon. However, during the peak

monsoon period, particularly in July and August, rainfall values were relatively uniform, indicating more stable rainfall conditions during this period.

This observation suggests that rainfall distribution was more consistent in July and August when compared to the rest of the monsoon period. A similar pattern was identified based on the standard deviation of daily rainfall, with maximum variability recorded in June and minimum variability in September.

Probability values were interpreted from Figures 4.9 to 4.30, and summarized in Table 4.6. Weekly rainfall at selected probability levels during the monsoon period is illustrated in Figure 4.32. Based on this analysis, rainfall at fifty, sixty and seventy percent probability increased gradually from the twenty second to the thirty fifth week. A sharp rise was noticed during the thirty sixth week, followed by a steady increasing pattern until the forty first week. Rainfall values dropped sharply to below ten millimetres after the forty second week and reached nearly zero after the forty third week.

The analysis further indicates that dependable rainfall at seventy percent probability is available from the twenty eighth to the forty first week. Similarly, rainfall at fifty and sixty percent probability is also available during the same period.

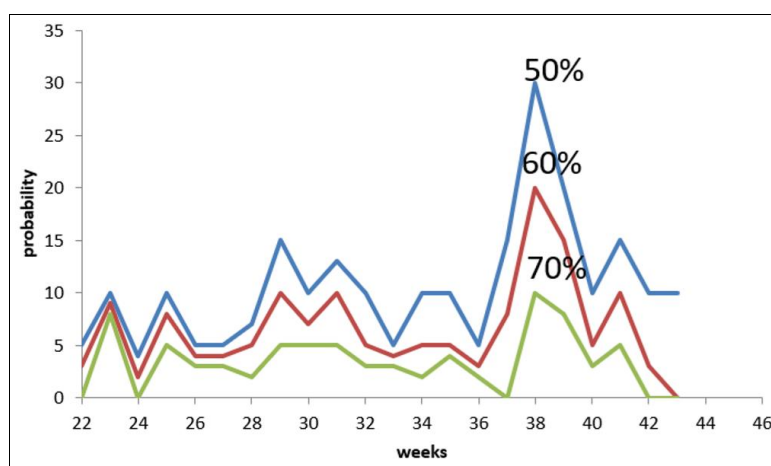


Fig 5: Weekly Rainfall at different probabilities at Masarguppi (Athani)

### 3.4 Dry and wet spell analysis

The analysis of dry and wet spells was carried out using the Markov chain model, which helped in understanding the rainfall pattern and duration of dry and wet periods in Masaragupi village located in Athani Taluk.

#### 3.4.1 Initial and conditional probabilities of dry and wet spells

The initial and conditional probabilities of weekly dry and wet spells were assessed using the standard procedure of the Markov chain model. A threshold of twenty millimetres of rainfall was considered to classify a week as wet. Probabilities were calculated for all 52 standard meteorological weeks and are presented in Table 4.8. Out of these, 32 weeks were found to be wet. The highest probability of a wet week was recorded during the thirty eighth week, with a value of sixty seven percent.

### 3.5 Meteorological Drought

The assessment of meteorological drought years at the study location is presented in Table 4.10, where drought intensity has been categorized into mild, moderate, severe and extreme classes. Analysis of the 15 year period (2005 to 2019) revealed that 5 years, namely 2005 (-9.5), 2015 (-17.1), 2016 (-7.1), 2017 (-14.9) and 2018 (-23.8), were affected by mild drought conditions. Additionally, two years, 2011 (-29.6) and 2012 (-37.9), experienced moderate drought.

### 3.6 Variation of Rainfall in Quantity

It is seen from the analysis of rainfall from previous sections that the rainfall at Masarguppi (Athani) is more during months of June-September. It will be of utmost important to know the potential water demand of crops during its growing period. Figure 4.32 presents the distribution of weekly rainfall and Potential Evapotranspiration (PE) over the year. The meteorological data has been collected from Vijayapura region, though which the PT data has been extracted, it can be seen from Figure 4.32 that except during 36 to 45 weeks, the weekly PE values exceeds rainfall during other all weeks. This indicates that short duration (90-100 days) crops can be taken in the monsoon season. Also, from the assessment of moisture availability confirms that the dry land cropping is also possible at Masarguppi (Athani).

It is observed that the probabilities of holding wet conditions as well as wet followed by wet conditions, cross the 70 per cent threshold, only during few weeks. It is observed from the probability analysis of weekly rainfall (Section 4.2.2) that at 70 per cent probability level, sufficient amount of rainfall is available during 28<sup>th</sup> to 41<sup>st</sup> weeks, with maximum amount of 10 mm rainfall available during

39<sup>th</sup> week, looking in to the expected rainfall patterns the farmers can be advised for sowing of crops such as maize, sorghum and black gram in the 28<sup>th</sup> to 29<sup>th</sup> weeks, as the rainfall is expected in 29<sup>th</sup> and subsequent weeks.

The first weeding operation can be completed during 37<sup>th</sup> week, as the rainfall after 37<sup>th</sup> week is comparatively much higher. Again, second weeding and other intercultural operations can be completed in 40<sup>th</sup> week for the crops sown during 28<sup>th</sup> week and in the 41<sup>st</sup> week for the crops sown during 29<sup>th</sup> week.

The total continuous duration of rainfall at 70 per cent probability level is in between 85-95 days. Further as already described earlier, it was found that any crop type and variety with total duration in between 80-110 days can be successfully harvested at Masarguppi (Athani). There is no appreciable rainfall available after 41<sup>st</sup> week at 70 per cent chance. So, it is preferable to opt for early varieties to avoid chances of life saving irrigations.

### 3.7 Resource planning in Agriculture

Crop planning and technical design of various soil and water conservation and hydraulic structures play a key role in sustainable crop production, moisture conservation and helps in avoiding erosion of soil which are responsible for maintaining ecological balance of natural resources in agriculture. This can be well met out with critical analysis of rainfall and adapting suitable measures in a technical manner.

#### 3.7.1 Crop planning in Agriculture

Based on the findings of dry spells and information pertaining to critical crop growth stages and durations, critical analysis was done in relation with withdrawal of rainy season and suitable dates for three major crops for Masarguppi (Athani) were suggested and optimal sowing dates would be 30<sup>th</sup> SMW and 25<sup>th</sup> SMW (for early sowing) for maize; 30<sup>th</sup> SMW and 27<sup>th</sup> SMW (For early sowing) in sorghum respectively.

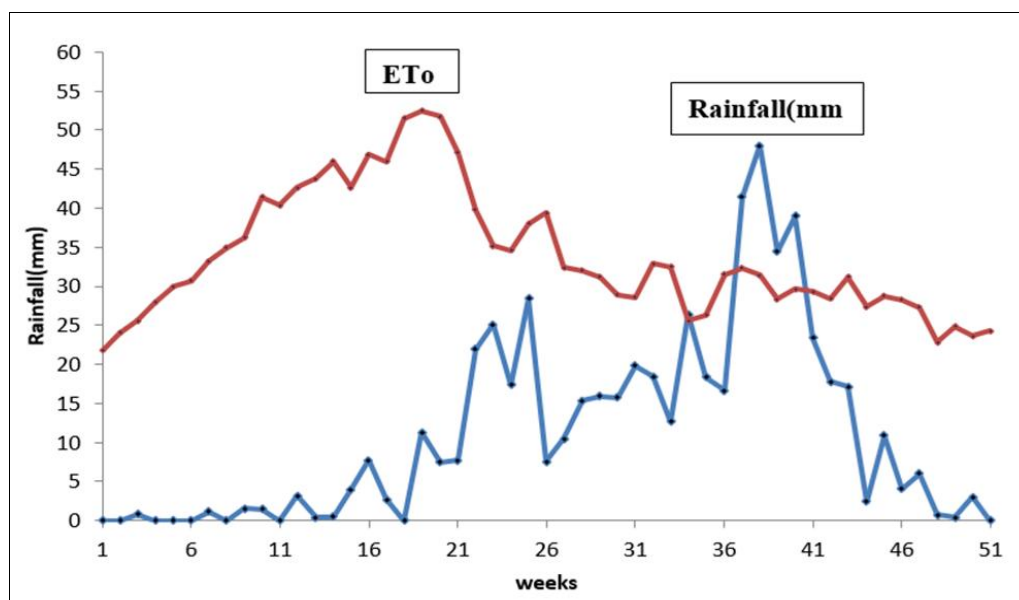


Fig 6: Distribution of weekly rainfall and Potential Evapotranspiration at Masarguppi (Athani)

### 3.8 Soil Data Analysis

**Table 2:** Result of Soil pH analysis

| Soil Sample No. | pH   |
|-----------------|------|
| 01.             | 7.5  |
| 02.             | 7.91 |
| 03.             | 8.37 |
| 04.             | 8.32 |
| 05.             | 7.58 |

Table 2 presents the data obtained from soil samples collected from five locations in Masarguppi Village, Athani, situated in Belagavi District. Laboratory analysis was conducted on these samples to determine the pH and electrical conductivity (EC) values. Soil pH plays a crucial role in regulating soil biogeochemical processes in natural environments.

It is often referred to as the “master soil variable” due to its significant influence on numerous biological, chemical and physical properties of soil, which in turn directly impact plant growth and crop productivity.

#### 3.8.1 Soil EC Analysis

**Table 3:** Result of Soil EC analysis

| Soil Sample No. | EC   |
|-----------------|------|
| 01.             | 4.6  |
| 02.             | 0.32 |
| 03.             | 0.34 |
| 04.             | 0.32 |
| 05.             | 1.03 |

Soil electrical conductivity (EC) represents the concentration of soluble salts present in the soil and serves as a key indicator of soil salinity. It is widely used to assess soil health, as elevated salt levels can interfere with plant development by disrupting the soil-water balance. Naturally high salt content in soils is commonly observed in arid and semi-arid regions, where limited rainfall contributes to salt accumulation in the upper soil layers.

### 4. Summary and Conclusion

A thorough understanding of rainfall characteristics and soil-water parameters is essential for effectively utilizing available water resources, particularly in dryland agriculture where rainfall is the primary source of water. Recognizing the critical role of rainfall distribution in crop growth and development, the present study analyzed rainfall patterns in Masarguppi village, Athani taluk of Belagavi district, using 15 years of daily rainfall data (2005-2019).

#### Major Findings

- Soil and water samples were collected from multiple locations across the study area to examine their physical and chemical properties. A total of five soil samples and six water samples were analyzed.
- The average soil pH was found to be 7.936, indicating high alkalinity, particularly near the stream side.
- The average soil electrical conductivity (EC) was 1.322 dS/m.
- The average pH of water samples was 7.10, reflecting near-neutral conditions.
- The average EC of water samples was 3.82 dS/m.

Statistical analysis was performed using daily rainfall data spanning 15 years. Rainfall characteristics were assessed on

daily (June-September), weekly, and annual scales using parameters such as mean, standard deviation, and coefficient of variation.

Daily rainfall during June exhibited high variability in both timing and intensity, while rainfall during July and August was comparatively stable, indicating more reliable distribution during peak monsoon months.

Weekly rainfall analysis showed that approximately 80% of the total annual rainfall occurred between weeks 22 and 40, with minimal variation from mean values during the core monsoon period (23rd-39th standard meteorological weeks).

Probability analysis using Weibull's plotting position indicated that at 70% probability, rainfall was dependable between the 25th and 41st weeks. Further, using the Markov chain model, the continuity of wet conditions was found to persist for 16 weeks (23rd-39th SMW). It was also noted that wet periods were commonly preceded by dry periods during the monsoon season.

### 4. Conclusion

Based on the study outcomes, the following conclusions are drawn:

1. Annual rainfall ranged from 356.1 mm to 790.7 mm during the study period.
2. The highest annual rainfall was recorded in 2019 (790.7 mm), followed by 2009 (722.5 mm) and 2014 (721.1 mm).
3. The lowest annual rainfall occurred in 2012 (356.1 mm), followed by 2011 (403.4 mm) and 2018 (460.6 mm).
4. Daily rainfall stability was observed to be greater during July and August, compared to the early and late monsoon months (June and September). Weekly rainfall remained fairly uniform in both distribution and magnitude between 22nd and 40th weeks.
5. Annual rainfall variation was minimal, and a recurrence cycle of 5-6 years was observed with similar rainfall patterns.
6. Dependable rainfall at 70% probability was available between the 25th and 41st weeks, indicating a 16-week window (25th-41st SMW) suitable for kharif crop planning under rainfed conditions at 50%, 60%, and 70% probability levels.
7. Analysis of initial and conditional probabilities (considering 20 mm threshold) revealed that monsoon weeks (23rd-39th SMW) were generally preceded by dry periods, with rainfall distribution confined mainly to 25th-41st weeks.
8. Evaluation of meteorological drought conditions indicated that, during the 15-year period (2005-2019), five years experienced mild drought and two years moderate drought, accounting for 46% of the study duration.

### 6. References

1. Ahmed P, Deka RL, Baruah BP, Nath KK. Rainfall based crop planning in the *Barak valley* zone of Assam. *Journal of Agrometeorology*. 2009;11(2):192-195.
2. Kumar A. Prediction of annual maximum daily rainfall of Ranichauri (Tehri Garhwal) based on probability analysis. *Indian Journal of Soil Conservation*. 2000;28(2):178-180.
3. Arthi RB, Manikandan N, Maragatham N. Trend analysis of rainfall and frequency of rainy days over Coimbatore. *Mausam*. 2014;65(5):379-384.
4. Babu PN, Lakshminarayana B. Rainfall analysis of a dry land watershed—Polkepad: A case study. *Journal of Indian Water Resources Society*. 1997;17(3):34-38.
5. Banik P, Sharma RC. Rainfall pattern and moisture availability index in relation to rice (*Oryza sativa* L.) crop

- planning in eastern plateau region of India. *Journal of Agrometeorology*. 2009;11(1):54-58.
6. Barman D, Saha AR, Kundu DK, Mahapatra BS. Rainfall characteristics analysis for jute based cropping system at Barrackpore, West Bengal, India. *Journal of Agricultural Physics*. 2012;12(1):23-28.
  7. Baweja PK. Rainfall variability and probability for crop planning in Solan, Himachal Pradesh. *Journal of Farm Science*. 2011;1(1):75-88.
  8. Bhargava AK, Singh PK, Vasu M, Awadhesh P, Jayapalan M. Rainfall variability and probability pattern for crop planning of Roorkee region (Uttarakhand) of India. *Mausam*. 2010;61(4):509-516.
  9. Chand M, Kumar D, Singh D, Roy N, Singh DK. Analysis of rainfall for crop planning in Jhansi district of Bundelkhand zone of Uttar Pradesh. *Indian Journal of Soil Conservation*. 2011;39(1):20-26.
  10. Chand R, Singh UP, Singh YP, Siddique LA, Kore PA. Analysis of weekly rainfall during rainy season over Safdarjung airport of Delhi for 20th century: A case study on trend, decile and decadal analysis. *Mausam*. 2011;62(2):197-204.
  11. Dash MK, Senapati PC. Forecasting of dry and wet spell at Bhubaneswar for agricultural planning. *Indian Journal of Soil Conservation*. 1992;20:75-82.
  12. De GC, De P. Agro-meteorological conditions of Sriniketan, West Bengal. *Journal of Agrometeorology*. 2003;5:129-133.
  13. Kumar D, Chandola Y, Rastogi A. Comparison of probability distributions for analysis of data. *Indian Journal of Soil Conservation*. 2000;28(2):110-116.
  14. Dixit AJ, Yadav ST, Kokate KD. The variability of rainfall in Konkan region. *Journal of Agrometeorology*. 2005;7(2):322-324.
  15. Ghadekar SR, Miskin RB. A study on the characterization of monsoon rainfall for sorghum (*Sorghum vulgare* Pers) and its response to typical rainfall patterns. *Mausam*. 1998;49:115-120.
  16. Gouranga K. Initial and conditional probabilities of rainfall and dry spell for red and lateritic zones of West Bengal using Markov chain model. *Indian Journal of Soil Conservation*. 2003;31(1):287-290.
  17. Jat ML, Sammauria R, Balyan JK, Sharma RK. Crop planning in semi-arid tracts of Udaipur region based on analysis of weekly rainfall. *Indian Journal of Soil Conservation*. 2010;38(2):69-74.
  18. Jhajharia D, Shrivastava SK, Tulla PS, Sen R. Rainfall analysis for drought proneness at Guwahati. *Indian Journal of Soil Conservation*. 2007;35:163-165.
  19. Kar G, Verma HN, Singh R. Effect of winter crop and supplemental irrigation on crop yield, water use efficiency and profitability in rainfed rice based cropping system of eastern India. *Agricultural Water Management*. 2006;79:280-282.
  20. Kar SK, Sahoo DP, Subudhi CR. Weekly analysis for crop planning using Markov chain model for Kandhamal district of Odisha, India. *International Journal of Engineering Research and Applications*. 2014;9(4):139-145.
  21. Kavi PS. The performance consistency of seasonal rainfall in Gulbarga district during last 30 years. *Karnataka Journal of Agricultural Sciences*. 1994;7(2):194-200.
  22. Khichar ML, Niwas R, Pal S. Markov chain model for analysis of southwest monsoon rainfall of arid zone in Haryana. *Journal of Applied Hydrology*. 2000;13(3-4):60-65.
  23. Kothari AK, Jain PM, Kumar V. Analysis of weekly rainfall data using onset of monsoon approach for micro-level crop planning. *Indian Journal of Soil Conservation*. 2009;37(3):164-171.
  24. Kumar V. Rainfall characteristics of Shimla district (Himachal Pradesh). *Journal of Indian Water Resources Society*. 2003;23(1):1-10.
  25. Majumder A, Ghosh A, Pal S, Saha A. Rainfall pattern and crop planning in two agroclimatic zones of West Bengal under rainfed rice cultivation. *Journal of Agrometeorology*. 2005;7(1):44-50.
  26. Manikandan N, Arthi RB, Sathyamoorthi K. Weekly rainfall variability and probability analysis for Coimbatore in respect of crop planning. *Mausam*. 2014;65(3):353-356.
  27. Manorama K, Ravichandran G, Joseph TA. Rainfall analysis and crop planning for the Nilgiris. *Journal of Agrometeorology*. 2007;9:209-215.
  28. Metalas CN. Probability distributions of low flows. Geological Survey Professional Paper 434-A. U.S. Government Printing Office, Washington; 1963.
  29. Mishra AK, Sarkar TK, Bhattacharya AK. Stochastic rainfall forecasting for weekly water resource assessment in Lower Assam. *Indian Journal of Soil Conservation*. 1999;27(2):99-111.
  30. Mishra KK. Water excess and deficits using coefficient of varieties of weekly rainfall. *Journal of Agricultural Engineering*. 2002;39(2):44-52.
  31. Mishra NK, Satyariarvana T. Effects of extreme events on statistical parameters of rainfall at Khargpur, West Bengal. *Journal of Agricultural Engineering, ISAE*. 1987;24(1):74-86.
  32. Nath KK, Deka RL. Perturbations of climatic elements of Jorhat, Assam. *Journal of Agrometeorology*. 2002;4:87-91.
  33. Pandey V, Shekh AM, Parmar RS. Occurrence of drought and floods over Gujarat. *Journal of Agrometeorology*. 1999;1:177-182.
  34. Panigrahi B, Panda SN. Dry spell probability by Markov chain model and its application to crop planning in Kharagpur. *Indian Journal of Soil Conservation*. 2002;30(1):95-100.
  35. Parasuram P, Suresh M. Study on the rainfall climatology of regional research station, Paiyur for crop planning. *Madras Agricultural Journal*. 2002;89(7-9):469-473.
  36. Parmar RS, Akula B, Shekh AM, Jhala AJ. Climatic variability in Gujarat state, India. *Journal of Agrometeorology*. 2005;7:214-219.
  37. Patil PP, Patil MM. Relationship between extreme events and statistical parameters of rainfall at Dhule, Maharashtra. *Indian Journal of Soil Conservation*. 1991;19(1-2):75-82.
  38. Patle GT. Probability of consecutive days annual maximum rainfall for the design of surface drains in semi-arid Maharashtra. *Indian Journal of Soil Conservation*. 2008;36(3):144-147.
  39. Pimpale AR, Hiwase SS, Paul PG. Probability of rainfall at Akola, Maharashtra. *Journal of Soil and Water Conservation, India*. 2001;45(3-4):129-132.
  40. Rai SK, Srivastava AK. Variation of weekly rainfall pattern at Raipur. *Mausam*. 1996;47:191-204.
  41. Rao GSLHV P, Kumar KNK. Monsoon onset over Kerala, India: 1870-2004. *Journal of Agrometeorology*. 2005;7:161-167.
  42. Rath H, Jena GN, Senapati PC. Forecasting of dry and wet spells at Boudh for agricultural planning. *Indian Journal of*

- Soil Conservation. 1996;24:28-36.
43. Rathod RK, Jadhav JD, Bhore AV, Bavadekar VR, Kadam JR. Probable rainfall and contingent crop planning for scarce rainfall zone of Maharashtra. *Journal of Agrometeorology*. 2013;15(1):123-127.
  44. Reddy RD, Sreenivas G, Mahadevappa SG, Lata MA. Rainfall variability and its impact on agriculture in north Telangana region of Andhra Pradesh. *Journal of Agrometeorology*. 2007;9(2):253-258.
  45. Saha A, Sarkar C. An assessment of climatic risk involved in growing rainfed rabi crops in different agroclimatic zones of West Bengal. *Journal of Agrometeorology*. 2005;7:36-43.
  46. Saha R, Mishra VK. Probability analysis of rainfall at Meghalaya for crop planning. *Indian Journal of Soil Conservation*. 2005;33:86-87.
  47. Sarkar J, Seetharam K, Shaha SK. Climatology of dry and wet spell over Vidarbha region during monsoon months. *Mausam*. 2001;52:365-370.
  48. Senapati SC, Sahu AP, Sharma SD. Analysis of meteorological events for crop planning in rainfed uplands. *Indian Journal of Soil Conservation*. 2009;37(2):85-90.
  49. Senthilvelan A, Ganesh A, Banukumar K. Markov chain model for probability of weekly rainfall in Orthanadu taluk, Thanjavur district, Tamil Nadu. *International Journal of Geomatics and Geosciences*. 2012;3(1):191-203.
  50. Sethy BK, Ali S, Prasad SN. Frequency analysis for one day to five consecutive days maximum rainfall for south-eastern Rajasthan. *Indian Journal of Soil Conservation*. 2005;33(1):22-26.
  51. Sharma D, Kumar V. Prediction of onset and withdrawal of effective monsoon dates and subsequent dry spells in an arid region of Rajasthan. *Indian Journal of Soil Conservation*. 2003;31:223-228.
  52. Singh M, Bhandari AR. Wet and dry spells analysis using Markov chain model for mid hill region of Himachal Pradesh. *Indian Journal of Soil Conservation*. 1998;26:147-152.
  53. Singh M, Singh R, Niwas R, Sahrawat D. Study on south-west monsoon rainfall characteristics in arid zone of Haryana. *Mausam*. 2003;54(4):837-842.
  54. Singh PK. Rainfall variability and crop planning in Sabour region of Bihar. *Journal of Agrometeorology*. 2005;7(2):284-290.
  55. Singh RS, Ramakrishna YSP, Purohit RS. Rainfall characteristics analysis of Kutch (Gujarat) region of India. *Annals of Zone*. 1991;30(2):93-100.
  56. Singh R, Rizvi RH, Kareemulla K, Dadhwal KS, Solanki KR. Rainfall analysis for investigation of drought at Jhansi in Bundelkhand region. *Indian Journal of Soil Conservation*. 2002;30:117-121.
  57. Soni OP, Kumar D. Rainfall pattern of south-west monsoon in Malwa region of Madhya Pradesh. *Indian Journal of Soil Conservation*. 2005;33:259-261.
  58. Subudhi CR, Sahoo M, Senapati SC. Rainfall probability analysis for crop planning in Kandhamal district of Orissa, India. *Indian Journal of Soil Conservation*. 2012;40(3):247-251.
  59. Suchit KR, Singh KA. Rainfall variability and probability for crop planning at Madhepura in Bihar. *Journal of Agrometeorology*. 2009;11(1):42-46.
  60. Sumathi I, Basu SS, Senthil S. Assessment of periodicity of drought occurrence in Perambutar region. *Madras Agricultural Journal*. 2000;87:724-727.
  61. Suresh R, Thakur AK. Statistical evaluation of extreme event and their effects on rainfall parameters at Pusa, Samastipur. *Journal of Indian Water Resources Society*. 1993;13(1-2):78-81.
  62. Ali MS, Kang GH, Yang HS, Jeong JY, Hwang YH, Park GB, Joo ST. A comparison of meat characteristics between duck and chicken breast. *Asian-Australasian journal of animal sciences*. 2007 May 2;20(6):1002-6.