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ORIGINAL ARTICLE

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Frequency Analysis of Five Days Antecedent Rainfall for Different Seasons for Kohima (Nagaland)

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ABSTRACT

In the present study, daily rainfall data recorded at Kohima for 26 years (1997-2022) were collected. Data were grouped by seasonal rainfall: monsoon, pre–monsoon, and post-monsoon. The 5-day total antecedent rainfall prior to the storm was calculated for three seasons and fitted to various probability distribution functions. The distribution with the lowest $\chi 2$ value was declared the best fit function. Using the best fit probability distribution function, 05 days antecedent rainfall(mm) under different antecedent moisture conditions (AMCs) and seasons were calculated for different return periods. Only 15.56 % of the total number of 5 days of antecedent rainfall fall under AMC-II conditions. Therefore, of all recorded events, 60.05 per cent fall under AMC-I and 24.39 per cent under AMC-III, necessitating adjustment of the curve number from AMC-II to AMC-I or AMC-III, respectively, to reflect these proportions of cases. Results of the turning point test statistics fall within the 5% significance level for all seasons and AMC conditions, indicating that the data set could be considered random. Log normal and Normal probability distribution functions were found to be the best-fit probability distribution functions for AMC-I and AMC-III rainfall for the post-monsoon season, respectively. Extreme value-I probability distribution function was found to be the best fit for the pre-monsoon season rainfall of AMC-II and AMC-III, and the monsoon season rainfall of AMC-II. The log Pearson Type III probability distribution function was found to be the best fit for monsoon-season rainfall of AMC-I and for pre-monsoon-season rainfall of AMC-I. The gamma probability distribution function was found to be the best fit for post-monsoon season rainfall in AMC-II. Across all three seasons and AMCs, 5-day incident rainfall increased with increasing recurrence interval. The estimated values of 5-day antecedent rainfall (mm) under different AMCs and seasons at different recurrence intervals can be used to predict runoff in Kohima (Nagaland).

1 | INTRODUCTION

Abstractions such as interception, depression storage, and soil moisture decrease direct runoff from total storm rainfall. Due to their complexity and variability, many runoff models simplify these mechanisms (Dabral *et al*., 2016). However, models often acknowledge that initial watershed moisture influences storm runoff, which is classified as Antecedent Moisture Conditions (AMC) based on recent rainfall. The AMC levels are: AMC I—dry soils with low runoff potential; AMC II—moderate moisture; AMC III—near saturation with high runoff potential. The AMC category is determined using 5-day antecedent rainfall totals. Specifically: for AMC I, the 5-day antecedent rainfall is less than 1.25 cm during the dormant season and less than 3.5 cm during the growing season; for AMC II, the 5-day antecedent rainfall ranges from 1.25–2.75 cm (dormant season) and 3.5–5.25 cm (growing season); for AMC III, the 5-day antecedent rainfall exceeds 2.75 cm (dormant season) and 5.25 cm (growing season) (Murty & Jha, 2009).

When appropriate antecedent rainfall data are available, they can be used for runoff prediction. Hydrological frequency analysis estimates future antecedent rainfall using probability distributions. No single distribution is universally accepted; the best one accurately describes observed data. Estimating the probability of 5-day antecedent rainfall for each AMC class is crucial for runoff and hydrological models. Kumar and Kumar (1989) analyzed 26 years of rainfall data from Pant Nagar, finding only 10.96% in AMC-II, suggesting curve number adjustments to AMC-I (49.92%) or AMC-III (39.12%). Using various distributions, they estimated 5-day antecedent rainfall for AMC classes I, II, III across recurrence intervals of 1.25, 2, 5, 10, 100 years. Kumar (1995) used 28 years of data from Pant Nagar for similar estimates. Sudhishri *et al*., (1995) estimated averages across Odisha stations and created an ISO-AMC map. Tiwari *et al*., (2006) showed antecedent moisture's impact on curve number and calculated AMCs. Dabral *et al*., (2016) analyzed 26 years of rainfall at Doimukh, classifying events into AMC categories, with only 10.61% in AMC-II, using various distributions for 1- to 100-year return periods. Pandey *et al*., (2019) employed a total of 55 single storm events selected between the years 1993 and 2012 for estimation. Antecedent moisture content (AMC) of the in Bhadokhar watershed, located in Gursarain block of Jhansi district, Uttar Pradesh by taking preceding five days rainfall for three conditions viz., AMC-I, AMC-II and AMC-III. It was observed that during the period, 33 rain storms were falling under AMC-I category.

Nagaland, a mountainous state in Northeast India, has Kohima as its capital, situated atop surrounding hills. The region receives about 1600 mm of annual rainfall from April to September. December is usually dry, while rainfall from January to March is minimal. However, no systematic study has been conducted on the frequency analysis of 5-day antecedent rainfall using probability distribution functions across different seasons and return periods for Kohima, Nagaland. Therefore, the present study aims to analyze 5-day antecedent rainfall and its statistical characteristics for the pre-monsoon, monsoon, and post-monsoon seasons, and to estimate 5-day antecedent rainfall for various return periods using suitable probability distribution functions for each season.

2 | MATERIALS AND METHODS

2.1 | Study Area and Data

For the present study, 26 years of daily rainfall data (1997–2022) recorded at Kohima (25°40′N, 94°07′E) (Fig. 1) were analyzed. The data were categorized into three seasons: pre-monsoon (March–May), monsoon (June–October), and post-monsoon (November–February). For each storm event, the 5-day total antecedent rainfall was calculated for all three seasons. In cases where one or two dry days occurred within the 5-day period, rainfall from the remaining four or three days was summed to estimate the 5-day antecedent rainfall. Monsoon and pre-monsoon seasons are the major growing seasons for crops, whereas post-monsoon includes winter, which is the dormant season in north-east India. Using the criteria given in Table1, antecedent rainfall was classified into AMC-I, AMC-II, and AMC-III categories for the three seasons. The number of events falling under each AMC class for different seasons was also determined.

2.2 | Statistical Analysis of Data

Mean, standard deviation, coefficient of variation, and coefficient of skewness were calculated for the 5 days of antecedent rainfall for AMC-I. AMC-II and AMC-III conditions using the formulae below.

HIGHLIGHTS

- Study is focussed on frequency analysis of five days antecedent rainfall for different seasons for Kohima (Nagaland).
- Across all seasons and AMC classes, the estimated 5-day antecedent rainfall values increased with increasing recurrence intervals.
- These estimates of rainfall under various AMCs and seasons at different recurrence intervals can serve as important inputs for runoff prediction for Kohima (Nagaland).

2.2.1 | Mean

Mean represents measures of central tendency. The arithmetic mean is given by

$$\overline{X} = \frac{1}{N}\sum_{i=1}^{N} X_i \qquad (1)$$

where, X = mean, X_i = variate and N = total number of observations

2.2.2 | Standard Deviation

This parameter, as a measure of variability, is most adaptable to statistical analysis.
It is computed by

$$S = \sqrt{\frac{\sum_{i=1}^{N}(X_i-\bar{X})^2}{(N-1)}} \qquad (2)$$

Where, S = standard deviation

2.2.3 | Coefficient of Variation

This is a dimensionless dispersion parameter usually expressed as a percent. It is given by

$$\mathrm{CV} = \frac{S}{\overline{X}} \qquad (3)$$

Where, CV= coefficient of variation

2.2.4 | Coefficient of Skewness

The coefficient of skewness was determined for each set of data from the formula given below:

$$\mathrm{Cs} = \frac{N^{\square}\, M_3}{(N-1)(N-2)\, S^3} \qquad (4)$$

Where, C_s = coefficient of Skewness

$$\mathrm{M}_3 = \frac{1}{N}\sum_{i=1}^{N}(X_i - \overline{X})^3 \qquad (5)$$

2.3 | Randomness Checking of the 5-Day Antecedent Rainfall Data

To assess the randomness of the 05-day antecedent rainfall data, the turning point test method was used. This test determines the number of turning points in the data. A turning point occurs when xi is either greater than both the preceding and succeeding values or less than both. Therefore, any of the conditions for variate xi-1<xi> xi+1 or xi-1 > xi < xi+1 indicate a turning point. The procedure for the test is outlined as follows:

1. The data were arranged in order of their occurrence.
2. Either of the conditions xi-1<xi> xi+1 or xi-1 > xi < xi+1 was applied to ascertain how many turning points were in the series.
3. Let the total number of turning points be p.
4. Expected number of turning points in the series is $E(p)=\frac{2(N-2)}{3}$,where N is the total number of data.
5. Variance of p is $Var(P)=\frac{(16N-29)}{90}$.
6. P can be expressed as a standard normal form $z=\frac{(p-E(p)}{SQRT(Var(p))}$

If the calculated value of z is within the critical range of ± 1.96 for 5% level of significance, the hypothesis of randomness of data was accepted.

TABLE 1 Rainfall limits for estimating antecedent moisture condition (AMC)

AMC	5 days antecedent rainfall(mm)	
	Dormant Season	Growing Season
I	Less than 12.5	Less than 35
II	12.5 to 27.5	35 to 52.5
III	Over 27.5	Over 52.5

(Source: Murty and Jha,2009)

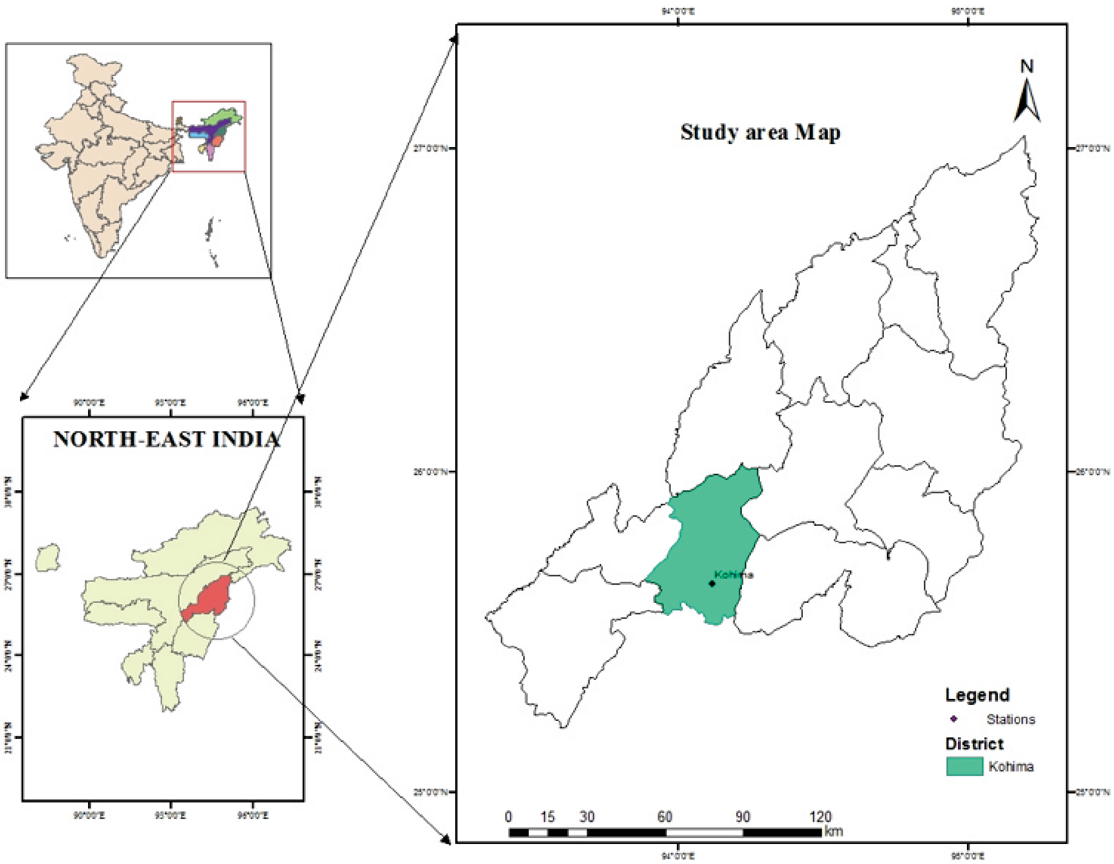

FIGURE 1 Location map of the Study area

2.4 | Fitting of Continuous Probability Distribution Functions

To evaluate the probabilistic behaviour of 5-day antecedent rainfall in Kohima, five continuous probability distribution functions were fitted and compared for their suitability. The distributions considered in this study were: i) Normal distribution (ND), ii) Log-Normal distribution (LND), iii) Gamma distribution (GD), iv) Log-Pearson Type III distribution (LPT-III), v) Extreme Value Type-I distribution (EVT-I). These distributions were selected based on their common application in hydrological frequency analysis. The mathematical expressions and properties of each distribution are summarized in Dabral *et al.* (2016) and Dabral (2025).

2.5 | Goodness of Fit of the Probability Distribution Functions

To assess the goodness of fit of the selected probability distribution functions, a comparison between the theoretical and observed relative cumulative frequencies was conducted using the Chi-square (χ^2) test. The χ^2 distribution functions are tabulated in many statistics texts. In the χ^2 test

$v = m-p-1$, where m= number of intervals, p = number of parameters used in fitting the proposed distribution. The null hypothesis H_0 assumes that the chosen distribution adequately fits the observed data. The hypothesis is rejected if the calculated χ^2 exceeds the critical value χ^2 from the Chi-square distribution at the chosen significance level α. Otherwise, the fit is considered acceptable. A common confidence level used is 95% (i.e., α=0.05).

2.6 | Frequency Analysis Using Frequence Factors

Chow (1951) has shown that many frequency analyses can be reduced to the following form:

$$X_T = \overline{X}\,(1 + CV.K_T) \qquad (6)$$

Where CV is the coefficient of variation, K_T is the frequency factor, $\overline{X}$ is the mean value of X, and X_T denotes magnitude of the event corresponding to a return period T.

For both ND and LND, the frequency factor can be expressed using the following equation (Chow, 1953):

$$K_T = \frac{(X_T - \mu)}{\sigma} \qquad (7)$$

Where, X_T is the magnitude of the hydrological event, K_T is the frequency factor, μ is the sample mean of the sample, and σ is the sample standard deviation of the sample. This expression is equivalent to the standard normal variable z. The value of z corresponding to an exceedance probability p (where $p = 1/T$) can be obtained by first calculating an intermediate variable 'w' :

where,

$$w = \left[ln\left(\frac{1}{p^2}\right)\right]^{1/2} \qquad (0 < p \leq 0.5) \qquad (8)$$

Then, calculating z using the equation

$$z = w - \left[\frac{(2.515517 + 0.802853w + 0.010328w^2)}{(1 + 1.432788w + 0.189269w^2 + 0.001308w^3)}\right] \qquad (9)$$

When $p > 0.5$, $1 - p$ is used in place of p in Equation (8), and the value of z is computed by Equation (9) is assigned a negative sign. For the EVT-I, Chow (1953) derived the corresponding expression:

$$K_T = -\,(\sqrt{6})\,/\,\pi\,[0.5772 + \ln\{\ln(\frac{T}{T-1})\}] \qquad (10)$$

Where T is the return period (in years).

For the Log-Pearson Type III distribution, the first step is to take the base-10 logarithms of the hydrological data. The mean, standard deviation, and coefficient of skewness are then computed from the logarithmic values. The frequency factor depends on the return period (T) and the coefficient of skewness, Cs. When $Cs = 0$, the frequency factor reduces to the standard normal variable z. However, when $Cs \neq 0$, K_T is approximated using the expression proposed by Kite (1977):

$$K_T = z + (z^2 - 1)\,k + \frac{1}{3}(z^3 - 6z)\,k^2 - (z^2 - 1)\,k^3 + z\,k^4 + \frac{1}{3}k^5 \qquad (11)$$

For the Gamma probability distribution function, the λ parameters (= mean $(S.D.)^{-2}$)β,(=(mean)^2 $(S.D.)^{-2}$) and v (=2xβ) were computed following the procedure suggested by Hann (1995). For a specified probability level, the value of χ^2 corresponding to the appropriate v was obtained from standard χ^2 tables. The expected rainfall at the given probability was calculated using the following relationship (Hann,1995):

$$Xp = \chi^2 / (2 \times \lambda) \qquad (12)$$

Frequency analysis was performed for the return periods listed in (Table 2).

TABLE 2 Return period and probability level

T (Return Period, Years)	1.053	1.25	2	10	20	25	50	100
P (Probability level in %)	95	80	50	10	5	4	2	1

3 | RESULTS AND DISCUSSION

3.1 | Five-Day Antecedent Rainfall Counts and Associated Statistical Parameters Across Seasons and Conditions

The distribution of 5-day antecedent rainfall under different conditions and seasons is presented in (Table 3). It is observed that only 15.56% of the total instances fall under AMC-II conditions. Consequently, of the total 5-day antecedent rainfall events, 60.05% fall under AMC-I and 24.39% fall under AMC-III. Since standard runoff estimation procedures are based on AMC-II, the curve number must be adjusted from AMC-II to AMC-I or AMC-III for these respective proportions of events. Standard conversion tables provide the necessary factors for this adjustment. Standard conversion tables are available to provide the necessary factors for adjusting the curve number from AMC-II to AMC-I and AMC-III.

TABLE 3 Numbers of 5-day antecedent rainfall under different conditions and seasons

Season	AMC-I	AMC-II	AMC-III	Total Numbers
Pre-monsoon	298	33	35	366 (28.62%)
Monsoon	347	137	263	747 (58.40%)
Post-Monsoon	123	29	14	166 (12.98%)
Total numbers	768 (60.05%)	199 (15.56%)	312 (24.39%)	1279

Dabral *et. al* (2016) analyzed 26 years (1988-2013) of daily rainfall data recorded at Doimukh (Itanagar), Arunachal Pradesh. They computed 5-day total antecedent rainfall preceding each storm for three different seasons and classified rainfall into AMC-I, AMC-II and AMC-III categories. Their analysis showed that only 10.61% of all 5 days antecedent rainfall values across the seasons fell within the AMC-II category.

3.2 | Statistical Parameters of 5-day Antecedent Rainfall Under Different Conditions and Seasons

Statistical parameters of 5 days of antecedent rainfall under different conditions and seasons are presented in (Table 4). During the pre-monsoon season, the mean, standard deviation, coefficient of variation, and coefficient of skewness under AMC-I, II, and III ranged from 13.09 mm to 45.48 mm, 4.75 to 20.99, 10.44% to 74.71%, and -0.07 to 1.45, respectively. In the monsoon season, the mean, standard deviation, coefficient of variation, and coefficient of skewness for AMC-I, AMC-II, and AMC-III were observed to range from 16.94 mm to 83.22 mm, 9.87 to 29.63, 15.47% to 58.26%, and -2.37 to 2.07, respectively. During the post-monsoon season, the corresponding mean, standard deviation, coefficient of variation, and coefficient of skewness under AMC-I, II, and III were found to be between 4.14 mm and 54.09 mm, 3.29 mm and 18.9 mm, 22.32% to 79.49%, and 0.49 to 0.95, respectively.

TABLE 4 Statistical parameters of 5 days antecedent rainfall under different conditions

S.No	Parameter	Pre-monsoon			Monsoon			Post-monsoon		
		AMC-I	AMC-II	AMC-III	AMC-I	AMC-II	AMC-III	AMC-I	AMC-II	AMC-III
1	Mean (mm)	13.09	45.48	41.65	16.94	44.15	83.22	4.14	17.56	54.09
2	Standard deviation (mm)	9.78	4.75	20.99	9.87	6.83	29.36	3.29	3.92	18.90
3	Coefficient of variation (%)	74.71	10.44	50.40	58.26	15.47	35.28	79.49	22.32	34.94
4	Coefficient of skewness	0.54	-0.07	1.45	0.01	-2.37	2.07	0.95	0.68	0.49

3.3 | Turning Point Test for Assessing the Randomness of Data

The turning point test was applied to assess the dataset's randomness. A null hypothesis of randomness was formulated and examined using the corresponding test statistic, with the results presented in (Table 5). For all seasons and AMC categories, the computed test statistics fell within the critical limits at the 5% significance level. Hence, the 5-day antecedent rainfall data under different AMC classes and seasonal conditions can be regarded as random.

TABLE 5 Result of turning point test

Season	AMC Class	P	N	E (P)	Var (P)	Z	Wheather data is Random or not ?
Pre-Monsoon	AMC-I	198	298	197.33	52.65	0.09	Random
	AMC-II	23	33	20.66	5.54	0.99	Random
	AMC-III	23	35	22	5.90	0.41	Random
Monsoon	AMC-I	231	347	230	61.37	0.13	Random
	AMC-II	96	137	90	24.03	1.22	Random
	AMC-III	181	263	174	46.43	1.03	Random
Post-Monsoon	AMC-I	72	123	80.67	21.54	-1.87	Random
	AMC-II	21	29	18	4.83	1.36	Random
	AMC-III	9	14	8	2.17	0.68	Random

Note : P= number of turning points, N= total number of data, E(P)= Expected number of turning points in the series, Var(P)= Variance of P, Z= test statistics

3.4 | Fitting and Evaluation of Different Probability Distribution Functions

Five-day antecedent rainfall values (mm) for the pre-monsoon, monsoon, and post-monsoon seasons under AMC-I, AMC-II, and AMC-III were used in their original form and fitted to various probability distribution functions, namely the ND, LND, GD, LPT-III, and EVT-I. The computed χ^2 statistics for each fitted distribution were then compared with the corresponding tabulated χ^2 values at the 5% significance level.

For the pre-monsoon season, the rainfall data for AMC-II and AMC-III were found to be significantly fitted by all the probability distribution functions. Based on the minimum χ^2 value, the EVT-I distribution emerged as the best-fitting model for both AMC-II and AMC-III rainfall during the pre-monsoon season. For AMC-I rainfall, the LPT-III distribution provided a statistically significant fit (Table 6).

For monsoon season, for AMC-I and AMC-II, LPT- III and EVT-I probability distribution function significantly fitted respectively. For AMC-III rainfall, LPT- III and EVT-I probability distribution function significantly fitted but EVT-I probability distribution function was the best fit based upon the lowest value of $\chi 2$ (Table 6).

For Post Monsoon season, for the rainfall of AMC-I, II and III all selected probability distribution functions fitted significantly. The best fit functions for AMC-I, II and III rainfalls were found to be Log normal, Gamma and Normal probability distribution functions respectively based on lowest value of $\chi 2$ (Table 6).

Dabral *et al.* (2016) conducted a frequency analysis of 5-day total antecedent rainfall for three seasons—pre-monsoon (March to May), monsoon (June to October), and post-monsoon (November to February) for Doimukh, Arunachal Pradesh, India. They fitted several probability distribution functions to the data and reported that all the selected distributions, namely ND, LND GD, LPT-III, and EVT- I, provided statistically significant fits for the 5-day antecedent rainfall across all three seasons.

TABLE 6 Chi-square value for different probability distribution functions

Season	AMC Class	Normal		Log Normal		Gamma		Log-Pearson III		Extreme Value-I		Class interval (m)
		Comp. $\chi 2$	Tabu $\chi 2$	Comp. $\chi 2$	Tabu $\chi 2$	Comp. $\chi 2$	Tabu $\chi 2$	Comp. $\chi 2$	Tabu $\chi 2$	Comp. $\chi 2$	Tabu $\chi 2$	
Pre-Monsoon	AMC-I	36.30	14.10	21.10	14.10	42.90	14.10	6.50*#	14.10	25.20	14.10	10
	AMC-II	2.00*	5.99	3.41*	5.99	2.11*	5.99	2.03*	5.99	1.73*#	5.99	5
	AMC-III	2.35*	5.99	3.83*	5.99	2.73*	5.99	3.20*	5.99	1.75*#	5.99	5
Monsoon	AMC-I	23.85	14.10	40.06	14.10	57.76	14.10	14.00*#	14.10	15.10	14.10	10
	AMC-II	17.62	14.10	15.9	14.10	17.20	14.10	17.60	14.10	13.34*#	14.10	10
	AMC-III	34.12	14.10	22.2	14.10	29.10	14.10	5.60*#	14.10	6.93*	14.10	10
Post-Monsoon	AMC-I	13.62*	12.6	3.90*#	12.6	14.00*	12.6	4.43*	12.6	12.14*	12.6	9
	AMC-II	2.66*	5.99	1.56*	5.99	0.96*#	5.99	5.50*	5.99	5.46*	5.99	5
	AMC-III	0.15*#	3.84	0.51*	3.84	0.35*	3.84	0.40*	3.84	0.25*	3.84	4

Best fit function, *Significant at 5 % level

3.5 | Estimation of 5 days Antecedent Rainfall (mm) Under Different AMC and Season at Different AMC Season at Different Recurrence Intervals

LND and ND were found to be best fit probability distribution function for AMC-I and III rainfall for post-monsoon season and (Table 7) presents the values KT for various return periods.

EVT-I probability distribution function was found the best fit for the Pre -monsoon season rainfall of AMC- II and AMC- III (Pre-monsoon season) and Monsoon season rainfall of AMC-II (section 3.4) and (Table 7) presents the values of K_T at various return periods.

LPT-III probability distribution function was found the best fit for monsoon season rainfall of AMC-I, III and Pre-monsoon season rainfall of AMC-I and (Table7) presents the values of K_T for various return periods.

Gamma probability distribution function was found best fit function for post- monsoon season rainfall of AMC-II and (Table 8) presents the value of $\chi 2$ and other parameters at various return periods.

Using the equation 6, values of K_T and other parameter ($\chi 2$) (Table7 and Table 8); 5 days antecedent rainfall (mm) under different AMC and seasons at different recurrence intervals were estimated and presented in (Table 9). It may be noted that for all three seasons and across all AMC classes, the estimated 5-day antecedent rainfall values increased consistently with an increase in the recurrence interval. These estimated antecedent rainfall values under different AMCs and seasons at various recurrence intervals can serve as useful inputs for runoff prediction for Kohima (Nagaland). The findings of the present study differ from those of Dabral *et al.* (2016), who conducted a similar study for Doimukh (Arunachal Pradesh).

TABLE 7 Values of K_T at various return periods for ND, LND and LPT-III

Return Period(T), years	Probability	K_T (Frequency Factor)				
		ND and LND	EVT - 1	LPT-III		
				Pre-Monsoon, AMC-I	Monsoon, AMC-I	Monsoon, AMC-III
1.053	0.95	-1.65	-1.04	-1.88	-2.84	-1.31
1.25	-0.84	-0.84	-0.82	-0.75	-0.60	-0.85
2	0.50	-0.0006	-0.16	0.17	0.25	-0.17
10	0.10	1.29	1.31	1.12	0.99	1.34
20	0.05	1.65	1.87	1.30	1.00	1.88
25	0.04	1.75	2.05	1.35	1.12	2.05
50	0.02	2.05	2.59	1.47	1.17	2.54
100	0.01	2.33	3.14	1.57	1.97	3.04

TABLE 8 Values of $\chi 2$ (ν=40) quantile for Xp estimation and other parameters at various return periods for Gamma probability distribution function (post-Monsson season rainfall for AMC-II)

T (years)	1.053	1.25	2	10	20	25	50	100
p	0.95	0.8	0.5	0.1	0.05	0.04	0.02	0.01
$\chi 2(\nu=40)$ quantile	5.8	21	22	39	42	44	46	48

Mean=17.6, SD=3.92, λ = 1.15, β = 20.16 and ν = 40

TABLE 9 Five days antecedent rainfall (mm) under different AMC and season at different recurrence intervals

Season	Condition	5 days antecedent rainfall(mm) at different recurrence interval (Years)							
		1.053	1.25	2	10	20	25	50	100
Pre-	AMC-I	1.1	3.7	10.3	29.5	36.2	38.2	43.6	48.6
Monsoon	AMC-II	40.6	41.6	44.7	51.7	54.3	55.2	57.8	60.4
	AMC-III	50.0	54.5	68.2	99.2	110.9	114.6	126.1	137.6
	AMC-I	0.8	6.9	15.8	33.1	35.8	37.15	39.8	40.2
Monsoon	AMC-II	65.6	38.55	43.04	53.11	56.91	58.13	61.87	65.62
	AMC-III	53.6	61.6	75.4	118.0	138.5	145.6	168.4	195.8
Post-	AMC-I	0.6	1.27	2.82	9.50	13.35	14.77	19.45	25.35
Monsoon	AMC-II	2.5	9.1	9.6	17.0	18.3	19.1	20.0	20.9
	AMC-III	23	38.2	54.1	78.4	85.2	85.6	92.8	98.9

4 | CONCLUSIONS

The predominance of AMC-I conditions (60.05%) over AMC-II (15.56%) at Kohima indicates that the watershed is dry for a substantial portion of the year, implying that direct application of standard AMC-II-based curve numbers would significantly overestimate runoff. Routine adjustment of curve numbers is therefore essential for reliable hydrological design in this region. The randomness of 5-day antecedent rainfall data across all seasons and AMC categories confirms the validity of applying classical frequency analysis techniques to this dataset, lending statistical credibility to the probability-based estimates derived in this study.

No single probability distribution function adequately describes antecedent rainfall behaviour across all seasons and moisture conditions at Kohima. This underscores the necessity of season- and AMC-specific distribution fitting rather than adopting a uniform distribution for regional hydrological analysis. The season- and AMC-specific antecedent rainfall estimates at return periods up to 100 years fill a critical data gap for Kohima, Nagaland, and can be directly integrated into SCS curve number-based runoff models, watershed management plans, and hydraulic infrastructure design for the region.

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CONFLICT OF INTEREST

The contributing authors have driven the manuscript and the study in unison hence no conflict of interest exists.

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DATA AVAILABILITY STATEMENT

The authors confirm that data supporting the results of the study is available within the manuscript.

AUTHOR'S CONTRIBUTIONS

All authors equally contributed to preparing the manuscript and data analysis.

REFERENCES

Chow, V. T. 1953. Frequency analysis of hydrological data with special application to rainfall intensities. Bulletin no.414, University of Illinois Eng. Expt. Station.

Chow, V.T. 1951. A general formula for hydrological frequency analysis. Trans. Am. Geophysical Union, 32(2):231-237.

Dabral, P. P., Choudhury, K. and Debbarma, S. 2016. Probability analysis of 5-day antecedent rainfall at different return periods and seasons for Doimukh (Itanagar), Arunachal Pradesh. *Indian J. Soil Conservation*, 44(3):332-335.

Dabral, P. P. (2025). Frequency analysis for annual maximum rainfall for Kohima (Nagaland), India. Agricultural Engineering International: CIGR Journal. 27(2) :18-28.

Hann, C. T. 1995. Statistical methods in hydrology, East West Press edition., New Delhi.

Kite, G. W. 1977. Frequency and risk analysis in hydrology, Water Resources Publications, Fort Collins, Col.

Kumar, D. 1995. Runoff estimation using antecedent rainfall probabilities. *Indian J. Soil Conservation*, 23(1); 13-16.

Kumar, S. and Kumar, D. 1989. Frequency of seasonal antecedent rainfall conditions. *Indian J. Soil Conservation*, 17(1); 25 :28.

Murty, V. V. N., Jha, M. 2009. Land and Water Management Engineering, Kalyani Publishers, Ludhiana, Fifth Edition.

Pandey, Kant, Ravi., Gupta, Rajendra., Thomas, Alex., 2019. Runoff estimation using SCS-CN method for Bhadokhar watershed, Jhansi district, Uttar Pradesh. *Indian J. Soil Cons 47(3): 239-243.*

Sudhishri, S., Nayak, S. C., Sharma, S. D. and Pandey, N. C. 1995. Antecedent moisture conditions in Orissa. *Indian J. Soil Conservation*, 23(3) :251-253.

Tiwari, A. K., Bhatt, V. K., Bhattacharya, P., Agnihotri, Y. and Agrawal, R. K. 2006. Application of SCS Curve number model for estimation of runoff in forest micro-watershed of Shiwalik region. *Journal of Soil and Water Conservation*, India, 5(2) :64-68, 2006.

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