MAUSAM, **73**, 1 (January 2022), 37-58

551.577 : 551.553.21 (540.51)

Monsoon, post monsoon rainy days analysis by using normal, binomial distribution and discrete probability for south Gujarat

NEERAJ KUMAR and S. K. CHANDRAWANSHI*

Department of Agronmy, College of Agriculture, Bharuch, Navsari Agricultural University, Navsari – 396 450 (Gujarat), India

**Krishi Vigyan Kendra, Piproundh Katni, Jawaharlal Nehru Krishi Vishwa Vidhyalaya Jabalpur – 843 442 (Madhya Pradesh), India*

(*Received 16 April 2021, Accepted 2 November 2020*)

e mail : neeraj34012@gmail.com

सार – इस शोध पत्र में दक्षिण गुजरात में मॉनसून और मॉनसूनोत्तर ऋतु के मानक साप्ताहिकी (SW) 22 से 47 तक का विश्लेषण किया जाएगा। द्विपद वितरण पर ची-स्क्वायर परीक्षण से नवसारी के मॉनसून ऋतु के लिए द्विपद वितरण का मानक साप्ताहिक वर्षा के दिनों का विश्लेषण मानक सप्ताह (SW) 22 से 31, 33 और मानक सप्ताह (एसडब्ल्यू) 35 से 39 पाया गया और मॉनसूनोत्तर मानक सप्ताह (SW) 41 से 44 तक महत्वपूर्ण रहा। परिणाम से यह भी पता चलता है कि मॉनसून ऋतु के मानक सप्ताह 32 और 34 तथा मॉनसूनोत्तर मानक सप्ताह 40, 45, 46 और 47 ने गैर-महत्वपूर्ण परिणाम दर्शाए। विश्लेषण से पता चलता है कि मानक सप्ताह 32, 34, 40, 45, 16 और 47 के दौरान वर्षा समान रूप से वितरित नहीं हुई, जिससे द्विपद वितरण का परीक्षण अच्छी तरह फिट हो। नवसारी, भरूच और वलसाड के मॉनसून के मौसम के वर्षा के आंकड़ों से पता चलता है कि जून, जुलाई, अगस्त और सितंबर के महीने के लिए 10, 20 और 30% संभाव्यता स्तरों पर सामान्य वितरण वर्षा के दिनों के बढ़ने की संभावना को दर्शाता है। नवसारी और भरूच जिलों में मॉनसून के बाद अक्टूबर और नवंबर के महीनों में वर्षा के दौरान वलसाड जिले को छोड़कर घटती प्रवृत्ति का पता चलता है। द्विपद वितरण केवल उन मानक सप्ताहों में फिट बैठता है जिनमें वर्षा समान रूप से वितरित नहीं होती है। भरूच में ची-स्क्वायर टेस्ट पर द्विपद वितरण के मानक साप्ताहिक वर्षा के दिनों के विश्लेषण में पाया गया कि मानक सप्ताह (SW)25 मॉनसून ऋतु का केवल 10% और मॉनसूनोत्तर मानक सप्ताह (SW) 42 और 47 में गैर महत्वपूर्ण (5 और 10% स्तर महत्वपूर्ण) परिणाम दिखाता है,लेकिन SW 25 को 5% के स्तर पर महत्वपूर्ण पाया गया। वलसाड जिले के संबंध में, मॉनसून ऋतु के मानक सप्ताह 22 से 39 और मॉनसूनोत्तर ऋतु के 41, 42, 43 और 46 मानक सप्ताह महत्वपूर्ण परिणाम दिखाते हैं। परिणाम से पता चलता है कि भरूच के मॉनसून ऋतु के मानक सप्ताह 25 को छोड़कर मानक सप्ताह 22 से 39 और मॉनसूनोत्तर मानक सप्ताह 40, 41, 43, 44, 45 और 46 महत्वपूर्ण परिणाम दिखाता है। इसके अलावा, वलसाड जिले में मानक सप्ताह 40, 44, 45 और 47 महत्वपूर्ण परिणाम दिखाते हैं। वर्षा के दिनों के प्रवृत्ति विश्लेषण से पता चलता है कि नवसारी, भरूच और वलसाड जिलों के मॉनसून ऋतु में वृद्धि की प्रवृत्ति और मॉनसूनोत्तर ऋतु में कमी आई है। उपरोक्त परिणामों से पता चला है कि वर्षा वितरण समान रूप से वितरित नहीं है, इसलिए ऊपर दिए गए मानक सप्ताह में द्विपद वितरण का परीक्षण अच्छी तरह फिट होता है। आंकड़ों से यह भी पता चलता है कि वलसाड जिले के सिवाय शेष में वर्षा में घटती प्रवृत्ति रही है।

ABSTRACT. The analysis will be conducted for standard weekly (SW) 22 to 47 of monsoon and post monsoon season at south Gujarat. The standard weekly rainy days analysis of binomial distribution for monsoon season of Navsari on chi-square test on binomial distribution was found in standard week (SW) 22 to 31, 33 and standard week (SW) 35 to 39 and post monsoon in standard week (SW) 41 to 44 shows significant. The result also reveals that the monsoon season SW 32 and 34 and post monsoon season SW 40, 45, 46 and 47 revealed non-significant result. Analysis reveals the rainfall is not equally distributed during SW 32, 34, 40, 45, 16 and 47, so that the test of binomial distribution is a good fit. Monsoon season rainfall data of Navsari, Bharuch and Valsad reveals that the normal distribution at 10, 20 and 30% probability levels for the month of June, July, August and September shows the possibility of increasing rainy days occurrence. The Navsari and Bharuch districts during post monsoon season rainfall of months of October and November reveals decreasing tendency except Valsad district. The binomial distribution fit only those standard weeks in which rainfall is not equally distributed. The standard weekly rainy days analysis of binomial distribution on chi-square test in Bharuch was found that standard week (SW) 25 only 10% of monsoon season and in post monsoon standard week (SW) 42 and 47 shows non significant (5 and 10% level of significant) result, but SW 25 found significant at 5% level. In case of Valsad district, standard week 22 to 39 of monsoon season and in post monsoon season 41, 42, 43 and 46 standard

weeks shows significant result. The result reveals that the monsoon season of Bharuch standard weeks 22 to 39 except from 25 and post monsoon 40, 41, 43, 44, 45 and 46 shows significant result. Further, in Valsad district standard weeks 40, 44, 45 and 47 shows significant result. The trend analysis of rainy days shows that increasing trend in monsoon season and decreasing trend in post monsoon season of Navsari, Bharuch and Valsad districts. From above results observed that the rainfall distribution is not equally distributed so test of binomial distribution at above given standard week is a good fit. The data also shows that, decreasing tendency in rainfall was observed except Valsad district.

Key words – Rainy day analysis, Discrete probability, Gaussian distributions, Trend analysis.

1. Introduction

India, predominantly an agriculture-based economy, is largely dependent on the monsoon. The agriculture sector is the backbone of the Indian economy and thus, monsoon should be considered as the backbone of agriculture. The four-month South-West monsoon season, accounts for nearly 75 per cent of the country's total rainfall and plays a crucial rule as about 55-60 per cent of the area sown is still rain-fed. India gets nearly 53 per cent of its agricultural produce from the kharif season (June-September) compared to the rabi season (November-February), where the production is around 47 per cent. The impact of the monsoon is also crucial for rabi crops as it has an impact on the ground water and also reservoirs which are critical for rabi crops irrigation. Agriculture contributes some 14 per cent of gross domestic product (GDP) in Asia's third-largest economy and any divergence from the normal progress or distribution will have direct impact on the agricultural output and a cascading effect on the overall economy, food inflation and therefore, consumer spending in India. The onset of monsoon this year is late on schedule. Kumar *et al*. (1992) examined the trends in the total precipitation during and found increasing trends in the all most along the west coast of India and northwest India. Joshi *et al.* (2005) examined the trends in extreme rainfall indices for most of the extreme rainfall indices over the west coast and northwestern parts of Indian peninsula. However, very little work has been done on Gujarat state. Ray *et al*. (2009) studies climate variability and extreme weather events like cold wave and heat wave condition and heavy rainfall events in Gujarat and they recorded a significant steady increase in these events. Lunagaria *et al*. (2015) examined the rainfall patterns of Gujarat state, rainfall indices also showed no uniformity for any negative or positive trend over Gujarat. Total annual rainfall and extremely wet days were found to increase at more numbers of stations. As the rainfall is the parameter having very high variability, very few stations showed statistically significant trends. Thus, still there is ambiguity in the rainfall pattern for Gujarat state. In the context of climate change, it is pertinent to ascertain whether the characteristics of Indian monsoon are also changing. The Indian monsoon (June to September) rainfall is very crucial for the economic development, disaster management, hydrological planning for the country.

The state receives rain under the influence of South west monsoon only during the four months from June to September. However, the onset, withdrawal and duration of monsoon are not uniform throughout the state. In south Gujarat, the monsoon commences from the middle of June and lasts up to end of October, while in north Gujarat a little latter and end by about the middle of September. In Saurashtra region, it commences from second week of June and lasts up to second week of September. The India Meteorological department views Gujarat state as two Sub-divisions, Gujarat region and Saurashtra-Kutch region. The state's annual average rainfall is about 820 mm received in 30 rainy days. The annual average rainfall of Gujarat region is 970 mm received in 43 rainy days, while that of Saurashtra-Kutch region is only 580 mm received in an average of only 23 rainy days. The coefficient of variation (CV%) of rainfall for Gujarat region is 23% and that of Saurashtra- Kutch is 35 percent. Considering Bharuch-Deesa line, the rainfall in the state decreases towards west of the line (Sahu, 2007).

2. Data and methodology

The present study was carried out by using the 36 years (1980-2015) of daily meteorological data observed at Agro-meteorological observatory, at Navsari, Gujarat (20°57' N latitude, 72°54' E longitude and 10 m), past 26 years year data of Bharuch (22.98° N and 70.21°E, Altitude 3.0 m) and past 30 years data of Valsad district (22.35° N and 72.35°E, Altitude 6.10 m), all three stations comes under south Gujarat heavy rainfall zone, shown in Figs. 1&2.

2.1. *Discrete probability (Binomial distribution)*

Probability distribution is a scientific way of dealing with uncertainty and making informed. In practice, probability distributions are applied in such diverse fields as actuarial science. This distribution usually occurs while dealing with complementary events. A binomial distribution gives us the probabilities associated with independent, repeated Bernoulli trials. In a binomial distribution the probabilities of interest are those of

Fig. 1. Location map

Fig. 2. Location map of Gujarat

receiving a certain number of successes, *r*, in n independent trials each having only two possible outcomes and the same probability, *p*, of success (Lettenmaier *et al.*, 1994).

Binomial distribution is used to study the probability of wet and dry period during the life cycle of the crop. The probability of rainy day is p and dry is *q* = 1-*p*. If the probability of A (rainy day) is assumed to be independent of previous occurrence of A(φ) or a (dry day), the probability of *x* occurrences of A among n independent repetitions is:

$$px = P(X = x) = \binom{n}{x} p^x q^{n-x} = \frac{n!}{(n-x)!\,x!} p^x q^{n-x}$$

where,

$X = 0, 1, 2, \ldots, n$

$x! = 1 \times 2 \times 3 \times,\ldots, x_n$

$0! = 1$

The probability that there will be '*r*' or fewer successes in 'n' independent trials is given by the cumulative distribution as:

$$F(r) = P(X \le r) = \sum_{x=0}^{r} \binom{n}{x} p^x q^{n-x}$$

Binomial distribution is also used to study the return period. A binomial is any pair of variables (a & b) raised to the given power

$$(a+b)^n = a^n + na^{n-1}b + \frac{n!}{2!(n-2)!}a^{n-2}b^2 + \ldots + \frac{n!}{(i-1)!(n-i+1)!}a^{(n-i+1)}b^{(i-1)}$$

$$a + b = 1(\text{or}100\%)$$

Each expansion can be used to calculate a series of probabilities for a sequence of years given by '*n*'.

2.2. *Gaussian distribution (Normal distribution)*

The normal distribution is the most widely known and used of all distributions. The standard normal distribution is a special case of the normal distribution. It is the distribution that occurs when a normal random variable has a mean of zero and a standard deviation of one. The normal random variable of a standard normal distribution is called a standard score or a *z*-score. A normal distribution also is a fundamental mathematical assumption of many commonly used statistical techniques (Ben-Gai *et al.*, 1998).

The normal distribution is the most important continues distribution in climatological analysis. Its frequency or probability density function is given by:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-1/2(x-\mu/\sigma)2}$$

where,

μ = Population mean

σ = Population standard deviation

'μ' is best estimated by $\bar{x}$ and 'σ' by '*s*'. There are obtained from the sample values by the relationship

$$\bar{x} = \frac{1}{n}\sum_{0}^{n} x$$

$$S = \sqrt{\frac{\sum\left(x - \bar{X}\right)^2}{n-1}}$$

The normal distribution function cannot be expressed in terms of simple function, but must be evaluated by means of function expansion. Many tables of the normal distribution function and related function have been prepared using the variables.

$$U = \frac{x - \mu}{\sigma}$$

where, μ is called standardized variable. Using this variable, the distribution function becomes which can be converted to any desired normal distribution simply by varying 'μ' and 'σ'.

Thus, a single normal table with augment '*t*', which is also a table of distribution with mean 0 and standard deviation unity, may be used to obtain the probabilities for any normal distribution.

Skewed distribution is obtained in rainfall climatological series for short period for which the mean rainfall is small. As the period increases, several shorter periods are added together. Hence, as the mean value gets larger, the sum of the several component periods approaches a normal distribution.

The chi square statistic is defined as:

$$\chi^2 = \sum_i \frac{(O_i - E_i)^2}{E_i}$$

where, O_i is the observed number of cases in category i and E_i is the expected number of cases in category i. This chi square statistic is obtained by calculating the difference between the observed number of cases and the expected number of cases in each category. This difference is squared and divided by the expected number of cases in that category. These values are then added for all the categories and the total is referred to as the chi squared value.

3. Results and discussion

A common use of rainfall data is in the assessment of probability return periods of given rainfall at a given location. Such data can then be used in assessing flood discharges of given return through modeling or some empirical system and can thus be applied in schemes of flood alleviation forecasting and for the design of bridges and culverts. Navsari comes under south Gujarat heavy rainfall zone. South Gujarat receives 97 percent rainfall from South west monsoon (24 to 32 standard weeks) during the June to September. Normal rainfall of Navsari district is 1606 mm in 54 rainy days (Kumar *et al*., 2015). The analysis is carried out using the daily rainfall data of past years and the frequency distribution is calculated for monsoon (22 to 39 standard weeks) and post monsoon (40 to 47 standard weeks) seasons.

3.1. *Binomial distribution of Navsari*

3.1.1. *Monsoon season*

The standard weekly rainy days analysis of binomial distribution for monsoon season of Navsari district has been done on the basis of past 36 years rainfall data. The data reveals that highest value (1498.18) of chi-square test on binomial distribution was found in standard week (SW) 39. In SW 39th the number of rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were observed 19, 5, 2, 4, 2, 3, 0 and 1 times respectively. In SW 38th rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were scrutinized 9, 8, 8, 2, 3, 3, 1 and 2 times respectively with chi-square value (343.71). The Chi-square value 158.3799 was found in SW 37th, the rainy days come under this week 0, 1, 2, 3, 4, 5, 6 and 7 were noticed 7, 10, 3, 6, 1, 2, 5 and 2 times respectively. During SW week 37th, 38th and 39th the calculated value is more than the table value and therefore the hypothesis acknowledged significant results at 5% (14.07) and 10% (18.48) probability levels. It confirmed that the hypotheses of binomial distribution for 37th, 38th and 39th standard weeks are not a good fit, Table 1, *i.e*., result shows that the probability of weekly rainfall is well distributed in the weeks. Manikandan, *et al*., 2014 had found that probability of weekly rainfall is well distributed. Similarly, at SW 22nd to 39th of monsoon season analysis divulged significant results at both 5% (14.07) and 10% (18.48) probability levels the hypothesis of chi-square test for binomial distribution is not a good fit, except for 32nd and 34th standard weeks. In SW 34th the number of rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were perceived 1, 4, 10, 7, 6, 4, 3 and 1 times respectively with chi-square value (12.22). In SW 32nd rainy days 0, 1, 2, 3, 4, 5, 6 and 7

TABLE 1

Rainy days analysis of binomial distribution for monsoon season for Navsari

Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$	Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$
22	0	27	0.61	-3.66	0.44	23	0	19	0.29	4.57	1.45
	1	4	0.31	-11.53	8.56		1	5	0.39	-14.62	10.90
	2	2	0.07	-1.37	0.56		2	5	0.23	-6.44	3.62
	3	3	0.01	2.59	16.56		3	2	0.07	-1.70	0.78
	4	0	0.00	-0.03	0.03		4	5	0.01	4.28	25.45
	5	0	0.00	0.00	0.00		5	0	0.00	-0.08	0.08
	6	0	0.00	0.00	0.00		6	0	0.00	-0.01	0.01
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	26.14					Total	42.30
24	0	10	0.07	6.55	12.43	25	0	10	0.07	6.69	13.50
	1	6	0.22	-5.23	2.44		1	7	0.22	-3.98	1.44
	2	7	0.31	-8.68	4.80		2	5	0.31	-10.61	7.21
	3	2	0.24	-10.15	8.48		3	3	0.25	-9.32	7.05
	4	4	0.11	-1.65	0.48		4	4	0.12	-1.84	0.58
	5	5	0.03	3.42	7.43		5	4	0.03	2.34	3.30
	6	1	0.00	0.76	2.33		6	2	0.01	1.74	11.53
	7	1	0.00	0.98	59.56		7	1	0.00	0.98	54.44
				Total	97.96					Total	99.06
26	0	8	0.02	6.79	38.32	27	0	4	0.00	3.85	98.13
	1	3	0.12	-2.93	1.45		1	3	0.03	1.64	1.96
	2	6	0.25	-6.50	3.38		2	0	0.11	-5.28	5.28
	3	6	0.29	-8.63	5.09		3	4	0.23	-7.37	4.78
	4	4	0.21	-6.28	3.84		4	9	0.29	-5.67	2.19
	5	2	0.09	-2.34	1.26		5	9	0.23	-2.37	0.49
	6	4	0.02	2.98	8.77		6	3	0.10	-1.89	0.73
	7	3	0.00	2.90	82.38		7	4	0.02	3.10	10.64
				Total	144.48					Total	124.21
28	0	4	0.00	3.85	98.13	29	0	0	0.00	-0.11	0.11
	1	3	0.03	1.64	1.96		1	3	0.02	1.93	3.49
	2	0	0.11	-5.28	5.28		2	5	0.09	0.51	0.06
	3	4	0.23	-7.37	4.78		3	6	0.21	-4.47	1.91
	4	9	0.29	-5.67	2.19		4	9	0.29	-5.66	2.18
	5	9	0.23	-2.37	0.49		5	4	0.25	-8.31	5.61
	6	3	0.10	-1.89	0.73		6	3	0.11	-2.75	1.31
	7	4	0.02	3.10	10.64		7	6	0.02	4.85	20.48
				Total	124.21					Total	35.15
30	0	3	0.00	2.90	82.38	31	0	2	0.00	1.85	22.64
	1	3	0.02	1.98	3.88		1	5	0.03	3.64	9.69
	2	3	0.09	-1.34	0.41		2	4	0.11	-1.28	0.31
	3	5	0.21	-5.28	2.71		3	3	0.23	-8.37	6.16
	4	5	0.29	-9.63	6.34		4	6	0.29	-8.67	5.13
	5	4	0.25	-8.50	5.78		5	4	0.23	-7.37	4.77
	6	7	0.12	1.07	0.19		6	8	0.10	3.11	1.98
	7	6	0.02	4.79	19.08		7	4	0.02	3.10	10.64
				Total	120.77					Total	61.32
32	0	0	0.00	-0.08	0.08	33	0	3	0.01	2.33	8.17
	1	1	0.02	0.18	0.04		1	6	0.08	2.02	1.02
	2	3	0.08	-0.76	0.15		2	3	0.20	-7.19	5.07
	3	11	0.19	1.48	0.23		3	9	0.29	-5.48	2.07
	4	6	0.29	-8.47	4.96		4	5	0.25	-7.35	4.37
	5	5	0.26	-8.20	5.09		5	4	0.13	-2.32	0.85
	6	7	0.13	0.31	0.01		6	5	0.04	3.20	5.71
	7	3	0.03	1.55	1.65		7	1	0.00	0.78	2.79
				Total	12.22					Total	30.05

Shows significance $P = 0.01$(<18.48) and $P = 0.05$(<14.07) and hypothesis accepted

TABLE 1 (*Contd.*)

Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$	Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$
	0	1	0.01	0.26	0.09		0	7	0.03	5.74	26.05
	1	4	0.09	-0.27	0.02		1	3	0.12	-3.11	1.58
	2	10	0.21	-0.58	0.03		2	8	0.25	-4.68	1.73
	3	7	0.29	-7.57	3.93		3	3	0.29	-11.60	9.22
34	4	6	0.24	-6.04	3.03	35	4	5	0.20	-5.10	2.57
	5	4	0.12	-1.97	0.65		5	6	0.08	1.81	0.78
	6	3	0.03	1.36	1.12		6	3	0.02	2.04	4.29
	7	1	0.00	0.81	3.35		7	1	0.00	0.90	8.59
				Total	12.22					Total	54.82
	0	4	0.02	3.05	9.84		0	7	0.04	4.92	11.64
	1	7	0.10	1.95	0.75		1	10	0.17	1.63	0.32
	2	7	0.23	-4.56	1.80		2	3	0.29	-11.44	9.06
	3	3	0.29	-11.68	9.30		3	6	0.28	-7.84	4.44
36	4	4	0.22	-7.19	4.62	37	4	1	0.16	-6.96	6.08
	5	5	0.10	-0.12	0.00		5	2	0.05	-0.75	0.20
	6	4	0.03	2.70	5.60		6	5	0.01	4.47	38.04
	7	2	0.00	1.86	24.38		7	2	0.00	1.96	88.59
				Total	56.29					Total	158.38
	0	9	0.08	5.11	6.69		0	19	0.21	8.73	7.42
	1	8	0.24	-3.99	1.33		1	5	0.36	-13.24	9.61
	2	8	0.32	-7.83	3.88		2	2	0.28	-11.88	10.17
	3	2	0.23	-9.61	7.96		3	4	0.12	-1.87	0.60
38	4	3	0.10	-2.11	0.87	39	4	2	0.03	0.51	0.17
	5	3	0.03	1.65	2.02		5	3	0.00	2.77	33.91
	6	1	0.00	0.80	3.25		6	0	0.00	-0.02	0.02
	7	2	0.00	1.99	317.72		7	1	0.00	1.00	1436.28
				Total	343.72					Total	1498.18

Shows significance $P = 0.01$(<18.48) and $P = 0.05$(<14.07) and hypothesis accepted

were discerned 0, 1, 3, 11, 6, 5, 7 and 3 times respectively with chi-square value (12.21). It reveals that the calculated value is less than the table value and therefore the test affirmed non-significant results at 5% (14.07) and 10% (18.48) probability levels. It concedes that the hypotheses of binomial distribution at 32nd and 34th standard weeks are a good fit Table 1. The result of both weeks indicates that rainfall distribution is not equal. Similar study was carried out by Sen and Eljadid (1999) at Libya.

3.1.2. *Post-monsoon season*

The highest value (3920.33) of chi-square test on binomial distribution was found in SW 43. In SW 43 the number of rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were observed 34, 1, 0, 0, 1, 0, 0 and 0 times respectively. In SW 41 rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were scrutinized 26, 5, 2, 1, 2, 0, 0 and 0 time respectively with chi-square value (79.93). Similarly, in SW 42 the chi-square value was found (33.19). In SW 42 the number of rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were discerned 31, 4, 0, 1, 0, 0, 0 and 0 times respectively. The analysis reveals that during SW 44 the number of rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were perceived 27, 4, 2, 3, 0, 0, 0 and 0 times respectively with chi-square value 26.1413. Chi-square analysis admits that during SW week 41st, 42nd, 43rd and 44th the calculated value is more than the table value and therefore the hypothesis affirms significant results at 5% (14.07) and 10% (18.48) probability levels. It notifies that the hypotheses of binomial distribution at 41st, 42nd, 43rd and 44th standard weeks are not a good fit, *i.e.*, result shows that probability of weekly rainfall well distributed in the weeks, Table 2.

The value (7.24) of chi-square test on binomial distribution was found in standard week SW 47. In SW 47 the number of rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were observed 33, 2, 1, 0, 0, 0, 0 and 0 time respectively. In SW 45 rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were scrutinized 32, 3, 1, 0, 0, 0, 0 and 0 time respectively with chi-square

TABLE 2

Rainy days analysis of binomial distribution for post monsoon season for Navsari

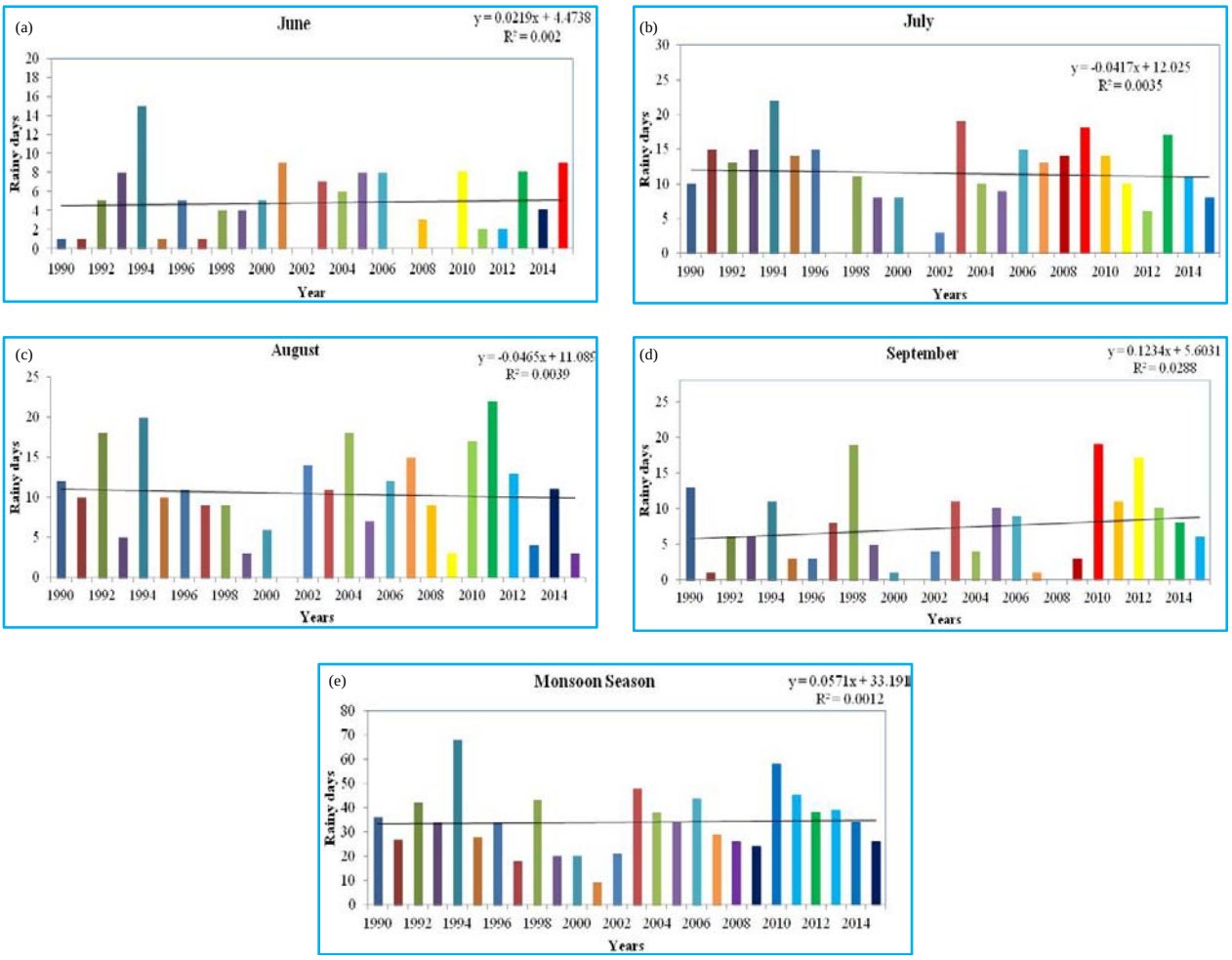
Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$	Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$
40	0	18	0.48	-6.06	1.53	44	0	27	0.61	-3.66	0.44
	1	12	0.37	-6.55	2.31		1	4	0.31	-11.53	8.56
	2	5	0.12	-1.13	0.21		2	2	0.07	-1.37	0.56
	3	1	0.02	-0.13	0.01		3	3	0.01	2.59	16.56
	4	0	0.00	-0.12	0.12		4	0	0.00	-0.03	0.03
	5	0	0.00	-0.01	0.01		5	0	0.00	0.00	0.00
	6	0	0.00	0.00	0.00		6	0	0.00	0.00	0.00
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	4.20					Total	26.14
41	0	26	0.56	-2.03	0.15	45	0	32	0.87	-11.46	3.02
	1	5	0.34	-11.91	8.39		1	3	0.12	-3.16	1.62
	2	2	0.09	-2.37	1.29		2	1	0.01	0.63	1.05
	3	1	0.01	0.37	0.22		3	0	0.00	-0.01	0.01
	4	2	0.00	1.95	69.89		4	0	0.00	0.00	0.00
	5	0	0.00	0.00	0.00		5	0	0.00	0.00	0.00
	6	0	0.00	0.00	0.00		6	0	0.00	0.00	0.00
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	79.93					Total	5.70
42	0	31	0.82	-10.05	2.46	46	0	31	0.84	-11.24	2.99
	1	4	0.16	-4.21	2.16		1	4	0.14	-3.21	1.43
	2	0	0.01	-0.70	0.70		2	1	0.01	0.47	0.42
	3	1	0.00	0.97	27.87		3	0	0.00	-0.02	0.02
	4	0	0.00	0.00	0.00		4	0	0.00	0.00	0.00
	5	0	0.00	0.00	0.00		5	0	0.00	0.00	0.00
	6	0	0.00	0.00	0.00		6	0	0.00	0.00	0.00
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	33.20					Total	4.87
43	0	34	0.87	-9.46	2.06	47	0	33	0.89	-11.70	3.06
	1	1	0.12	-5.16	4.32		1	2	0.10	-3.05	1.84
	2	0	0.01	-0.37	0.37		2	1	0.00	0.76	2.34
	3	0	0.00	-0.01	0.01		3	0	0.00	-0.01	0.01
	4	1	0.00	1.00	3913.57		4	0	0.00	0.00	0.00
	5	0	0.00	0.00	0.00		5	0	0.00	0.00	0.00
	6	0	0.00	0.00	0.00		6	0	0.00	0.00	0.00
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	3920.33					Total	7.25

Shows significance $P = 0.01$(<18.48) and $P = 0.05$(<14.07) and hypothesis accepted

TABLE 3

Analysis for normal distribution of occurrence of rainy days at different probability levels against normal for Navsari

Probability Levels (X)	Months						Seasons	
	Jun	Jul	Aug	Sep	Oct	Nov	Monsoon	Post-monsoon
0.10	11	21	19	13	5	4	55	5
Different percentage with normal rainy days	39.25	18.24	20.78	32.29	194.30	271.06	5.48	151.28
0.20	10	20	17	12	4	2	54	4
Different percentage with normal rainy days	22.97	10.68	12.16	18.90	113.71	136.74	2.90	88.51
0.30	10	19	17	11	3	2	53	3
Different percentage with normal rainy days	16.49	07.67	08.73	13.57	81.65	83.30	1.87	63.54
Normal rainy days	8	18	16	10	2	1	52	2

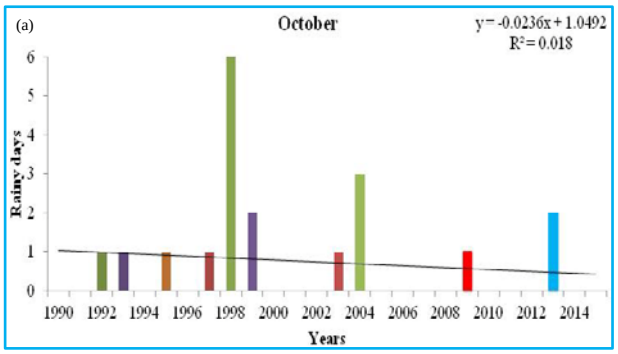


Figs. 3 (a-e). Monthly and monsoon season variability and trend at Bharuch district

value 5.70. In SW 46 the number of rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were contemplated 31, 4, 1, 0, 0, 0, 0 and 0 times respectively with chi-square value 4.86. The analysis reveals that during SW 40 the number of rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were espied 18, 12, 5, 1, 0, 0, 0 and 0 times respectively with chi-square value (4.19). Chi-square analysis acknowledges that during SW week 40^{th}, 45^{th}, 46^{th} and 47^{th}, the calculated value is less than the table value and therefore showed non-significant results at 5% (14.07) and 10% (18.48) levels. It divulges that the hypotheses of binomial distribution at 40^{th}, 45^{th}, 46^{th} and 47^{th} standard weeks are a good fit, Table 2. The result revels that at SW 40^{th}, 45^{th}, 46^{th} and 47^{th} that rainfall distributions are not equal. The average weekly rainfall distribution indicates very high positive value of coefficient of correlation (Chand *et al.*, 2011). Similar result was reported by (Seetharam, 2010) and Probability distribution function has been fitted for the region estimation of climate change in extreme rainfall series of each station (Guhathakurta *et al.*, 2005).

3.2. *Normal distribution*

The normal distribution analysis (10, 20 and 30% probability levels) has been done on the basis of past 36 years of monsoon season rainfall data for Navsari district. Analysis reveals the possibility of occurrence for minimum rainy days as per normal distribution at 10, 20 and 30% probability levels for the month of June, are 11, 10 and 10 respectively. The normal rainy days in month of June are 8. Normal distribution analysis at 10, 20 and 30% probability levels shows that the rainy days enrichment possibilities in terms of percentage are 39.25, 22.97 and 16.49 respectively. Correspondingly, the normal rainy days in a month of July are 18. The feasibility of incidences of minimum rainy days in July month at 10, 20 and 30% probability levels are 21, 20 and 19 respectively. The Normal distribution analysis acknowledges that at 10, 20 and 30% probability levels shows that the rainy days augmentation anticipation in terms of percentage are 28.24, 10.68 and 07.7



Figs. 4(a-c). Monthly and post monsoon season variability and trend at Bharuch district

respectively. Equivalently, in August month the possibility of instance of minimum rainy days at 10, 20 and 30% probability levels are 19, 17 and 17 respectively. The normal rainy days in a month of August are 16. The rainy days amplification probability at 10, 20 and 30% probability levels in terms of percentage are 20.78, 12.16 and 08.73 respectively (Table 3). Similarly for the month of September the possibility of appearance of minimum rainy days at 10, 20 and 30% probability levels are 13, 12 and 11 respectively.

Indistinguishably, the rainy days analysis of normal distribution at 10, 20 and 30% probability levels for the whole monsoon season concedes that the possibility of existence of minimum rainy days are 55, 54 and 53 respectively. The normal rainy days at Navsari district for monsoon season are 52. Analysis of normal distribution at 10, 20 and 30% probability levels reveals that the rainy days augmentation possibilities in terms of percentage are 5.48, 2.90 and 1.87 respectively. Analogously, in post monsoon season the possibility of exigency of minimum rainy days are 5, 4 and 3 at 10, 20 and 30% probability levels respectively. Analysis of normal distribution at 10, 20 and 30% probability levels divulges that the chances of rainy days augmentation prospects in terms of percentage are 151.28, 88.51 and 63.54 respectively, in Table 3, (Kumar *et al*., 2017).

3.3. *Trend in monsoon season*

3.3.1. *June*

The normal rainy days of June month are 8. The trend analysis showed significant increase in rainy days trend with an annual rate of 0.076 per year, Fig. 7(a).

3.3.2. *July*

The normal rainy days of July month are 18. The trend analysis showed significant increase in rainy days with an annual rate of 0.006 per year, Fig. 7(b).

3.3.3. *August*

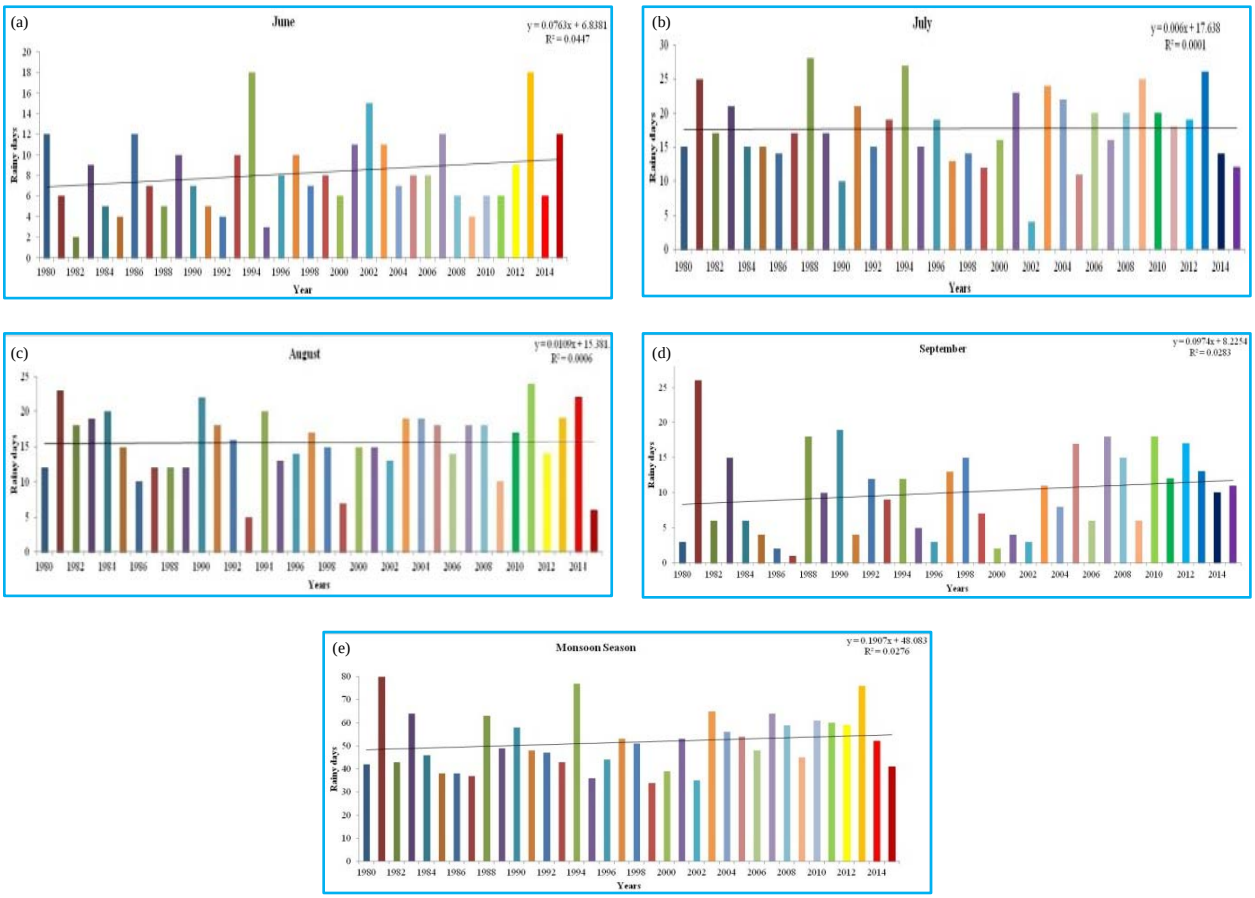
The normal rainy days of August month are 16. The trend analysis showed significant increase in rainy days trend with an annual rate of 0.010 per year, Fig. 7(c).

3.3.4. *September*

The normal rainy days of September month are 10. The trend analysis showed significant increase in rainy days trend with an annual rate of 0.097 per year, Fig. 7(d).

3.3.5. *Monsoon season*

The normal rainy days of monsoon season are 52. The trend analysis illustrated significant increase in rainy days with an annual rate of 0.190 per season, Fig. 7(e). The similar result was found for annual rainfall at Navsari shows the increasing trend (Kumar *et al*., 2015-I), (Jaswal and Rao, 2010), (Jaswal *et al*., 2015) and (Basu *et al*., 2004) the highest trend of monsoon rainfall anomalies of increasing nature is noticed. Kumar *et al*. (1992) identified the areas having decreasing and increasing trends of monsoon rainfall. Guhathakurta (2005) used nine-point Gaussian probability curve. It is clearly seen that no linear trend exists in this series. All India summer monsoon rainfall as well the rainfall during the four monsoon months does not show any significant trend.



Figs. 5(a-e). Monthly and monsoon season variability and trend at Valsad district

3.4. *Trend in post monsoon season*

3.4.1. *October*

The normal rainy days of October month are 2. The trend analysis showed significant decrease in rainy days with an annual rate of -0.011 per year, Fig. 8(a).

3.4.2. *November*

The normal rainy days of November month are 1. The trend analysis showed significant increase in rainy days with an annual rate of 0.004 per year, Fig. 8(b). The similar result was found for annual rainfall at Navsari shows the increasing trend (Kumar *et al*., 2015-I).

3.4.3. *Post monsoon*

The normal rainy days of post monsoon season are 2. The trend analysis showed significant decrease in rainy days with an annual rate of -0.007 per year, Fig. 8(c). Similar result was found (Kumar *et al*., 2015-I) and (Mohapatra, 2002) was found that rainfall rising trend during monsoon & falling trend during post monsoon (Chandrawanshi *et al*., 2017).

3.5. *Binomial distribution of Bharuch*

3.5.1. *Monsoon season*

The analysis of the standard weekly rainy days by binomial distribution for monsoon season of Bharuch on the basis of past 26 years data of rainfall, shows that the highest value (1612.16) of chi-square test on binomial distribution was found in standard week (SW) 26. In this week the number of rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were observed 12, 6, 3, 2, 0, 0, 2 and 1 times respectively during past 25 years. In SW 33 rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were observed 10, 3, 6, 2, 3, 1, 0 and 1 times respectively with chi-square value (375.04). In case of SW 36 chi-square value was 106.06 and the rainy days come under this week 0, 1, 2, 3, 4, 5, 6 and 7 with observed 9, 3, 4, 3, 1, 3, 2 and 1 times respectively. At SW 22nd to 39th except from SW 25th the calculated value is more than the table value and therefore the hypothesis showed significant results at 5% (14.07) and 10% (18.48)

TABLE 4

Rainy days analysis concerning binomial distribution for monsoon season of Bharuch district

Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i-e_i)^2}{e_i}$	Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i-e_i)^2}{e_i}$
22	0	20	0.65	-12.32	4.69	23	0	17	0.60	-12.76	5.47
	1	3	0.29	-11.55	9.17		1	7	0.32	-9.03	5.08
	2	1	0.06	-1.81	1.16		2	1	0.07	-2.70	1.97
	3	2	0.01	1.70	9.59		3	0	0.01	-0.47	0.47
	4	0	0.00	-0.02	0.02		4	1	0.00	0.96	25.45
	5	0	0.00	0.00	0.00		5	0	0.00	0.00	0.00
	6	0	0.00	0.00	0.00		6	0	0.00	0.00	0.00
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	24.64					Total	38.46
24	0	12	0.16	4.03	2.04	25	0	13	0.34	-4.00	0.94
	1	3	0.33	-13.73	11.27		1	5	0.40	-14.83	11.09
	2	4	0.30	-11.06	8.12		2	4	0.20	-5.91	3.53
	3	2	0.15	-5.53	4.06		3	3	0.06	0.25	0.02
	4	1	0.05	-1.26	0.70		4	1	0.01	0.54	0.64
	5	3	0.01	2.59	16.54		5	0	0.00	-0.05	0.05
	6	1	0.00	0.96	22.63		6	0	0.00	0.00	0.00
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	65.37					Total	16.26
26	0	12	0.20	1.81	0.32	27	0	7	0.07	3.59	3.79
	1	6	0.36	-12.20	8.17		1	3	0.22	-8.16	5.96
	2	3	0.28	-10.93	8.58		2	4	0.31	-11.66	8.68
	3	2	0.12	-3.92	2.60		3	6	0.24	-6.20	3.15
	4	0	0.03	-1.51	1.51		4	2	0.11	-3.71	2.41
	5	0	0.00	-0.23	0.23		5	3	0.03	1.40	1.22
	6	2	0.00	1.98	199.21		6	1	0.00	0.75	2.25
	7	1	0.00	1.00	1391.53		7	0	0.00	-0.02	0.02
				Total	1612.16					Total	27.48
28	0	5	0.05	2.73	3.29	29	0	4	0.02	3.01	9.08
	1	4	0.18	-4.82	2.64		1	4	0.10	-1.22	0.29
	2	5	0.29	-9.70	6.40		2	2	0.24	-9.75	8.09
	3	5	0.27	-8.62	5.45		3	4	0.29	-10.69	7.78
	4	1	0.15	-6.56	5.70		4	7	0.22	-4.02	1.46
	5	4	0.05	1.48	0.87		5	2	0.10	-2.96	1.76
	6	2	0.01	1.53	5.03		6	1	0.02	-0.24	0.05
	7	0	0.00	-0.04	0.04		7	2	0.00	1.87	26.26
				Total	29.41					Total	54.77
30	0	7	0.03	5.62	22.84	31	0	6	0.03	4.70	17.08
	1	2	0.13	-4.48	3.10		1	2	0.12	-4.21	2.86
	2	4	0.26	-9.02	6.24		2	2	0.26	-10.77	9.09
	3	3	0.29	-11.53	9.15		3	5	0.29	-9.59	6.30
	4	3	0.19	-6.73	4.65		4	5	0.20	-4.99	2.50
	5	2	0.08	-1.91	0.93		5	4	0.08	-0.11	0.00
	6	3	0.02	2.13	5.18		6	1	0.02	0.06	0.00
	7	2	0.00	1.92	43.98		7	1	0.00	0.91	8.98
				Total	96.08					Total	46.81
32	0	5	0.02	3.86	13.13	33	0	10	0.14	3.15	1.45
	1	3	0.11	-2.70	1.28		1	3	0.31	-12.74	10.32
	2	1	0.25	-11.27	10.35		2	6	0.31	-9.51	5.83
	3	7	0.29	-7.66	4.00		3	2	0.17	-6.49	4.96
	4	4	0.21	-6.51	4.03		4	3	0.06	0.21	0.02
	5	3	0.09	-1.52	0.51		5	1	0.01	0.45	0.37
	6	2	0.02	0.92	0.78		6	0	0.00	-0.06	0.06
	7	1	0.00	0.89	7.14		7	1	0.00	1.00	352.03
				Total	41.24					Total	375.04

Shows significance $P = 0.01$(<18.48) and $P = 0.05$(<14.07) and hypothesis accepted

TABLE 4 (*Contd.*)

Rainy days analysis concerning binomial distribution for monsoon season of Bharuch district

Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$	Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$
	0	7	0.09	2.74	1.77		0	7	0.08	2.97	2.19
	1	4	0.25	-8.57	5.84		1	6	0.24	-6.21	3.16
	2	5	0.32	-10.90	7.48		2	1	0.32	-14.86	13.93
	3	5	0.22	-6.18	3.42		3	5	0.23	-6.45	3.63
34	4	1	0.09	-3.72	2.93	35	4	4	0.10	-0.96	0.19
	5	3	0.02	1.81	2.73		5	2	0.03	0.71	0.39
	6	1	0.00	0.83	4.12		6	1	0.00	0.81	3.56
	7	0	0.00	-0.01	0.01		7	0	0.00	-0.01	0.01
				Total	28.30					Total	27.07
	0	9	0.07	5.59	9.18		0	10	0.12	4.14	2.92
	1	3	0.22	-8.16	5.96		1	4	0.29	-10.70	7.79
	2	4	0.31	-11.66	8.68		2	4	0.32	-11.80	8.81
	3	3	0.24	-9.20	6.94		3	1	0.19	-8.43	7.54
36	4	1	0.11	-4.71	3.88	37	4	4	0.07	0.62	0.11
	5	3	0.03	1.40	1.22		5	1	0.01	0.27	0.10
	6	2	0.00	1.75	12.26		6	2	0.00	1.91	42.21
	7	1	0.00	0.98	57.93		7	0	0.00	0.00	0.00
				Total	106.06					Total	69.50
	0	9	0.19	-0.71	0.05		0	14	0.26	1.08	0.09
	1	7	0.36	-10.93	6.66		1	1	0.39	-18.29	17.34
	2	4	0.28	-10.19	7.32		2	5	0.25	-7.34	4.37
	3	4	0.12	-2.24	0.81		3	4	0.09	-0.39	0.03
38	4	0	0.03	-1.65	1.65	39	4	1	0.02	0.06	0.00
	5	1	0.01	0.74	2.09		5	1	0.00	0.88	6.46
	6	1	0.00	0.98	41.61		6	0	0.00	-0.01	0.01
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	60.19					Total	28.31

Shows significance $P = 0.01$(<18.48) and $P = 0.05$(<14.07) and hypothesis accepted

probability levels. It acknowledges that the hypotheses of binomial distribution at those standard weeks are not a good fit (Table 4). The binomial distribution measures the probabilities of the number of successes over a given number of trials with a specified probability of success in each try. The aim of distribution fitting is to predict the probability or to forecast the frequency of occurrence of the magnitude of the phenomenon in a certain interval.

Among standard monsoon season weeks, 25th SW showed on significant results at 10% (18.48) probability level. In SW 25 the number of rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were observed 13, 5, 4, 3, 1, 0, 0 and 0time respectively with chi-square value (16.26). It reveals that the calculated value is less than the table value and therefore the test showed non-significant results at 10% (18.48) probability level. It concedes that the hypothesis of binomial distribution at 25th standard week is a good fit (Table 4).

3.5.2. *Post -monsoon season*

In case of post monsoon season, the highest value (42.16) of chi-square test on binomial distribution was found in standard week (SW) 42. In SW 42 the number of rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were observed 23, 2, 0, 1, 0, 0, 0 and 0 time respectively, followed by chi-square value (20.27) in SW 47. In SW 47 rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were observed 24, 0, 2, 0, 0, 0, 0 and 0 time respectively. Chi-square analysis affirms that during SW week 42th and 47th the calculated value is more than the table value and therefore the hypothesis shows significant results at 5% (14.07) and 10% (18.48) probability levels. It divulges that the hypothesis of binomial distribution at 42th and 47th standard weeks is not a good fit (Table 5).

From Table 5 the values11.66, 14.81, 11.53, 11.53, 11.56 and 11.56 of chi-square test on binomial distribution was found in standard weeks 40, 41, 43, 44, 45 and 46

TABLE 5

Rainy days analysis concerning binomial distribution for post monsoon season of Bharuch district

Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$	Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$
40	0	20	0.76	-18.00	8.52	41	0	22	0.79	-17.54	7.78
	1	5	0.21	-5.64	2.99		1	2	0.19	-7.44	5.86
	2	1	0.03	-0.28	0.06		2	2	0.02	1.03	1.11
	3	0	0.00	-0.09	0.09		3	0	0.00	-0.05	0.05
	4	0	0.00	0.00	0.00		4	0	0.00	0.00	0.00
	5	0	0.00	0.00	0.00		5	0	0.00	0.00	0.00
	6	0	0.00	0.00	0.00		6	0	0.00	0.00	0.00
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	11.66					Total	14.81
42	0	23	0.82	-18.14	8.00	43	0	25	0.96	-23.11	11.10
	1	2	0.16	-6.14	4.63		1	1	0.04	-0.86	0.40
	2	0	0.01	-0.69	0.69		2	0	0.00	-0.03	0.03
	3	1	0.00	0.97	28.84		3	0	0.00	0.00	0.00
	4	0	0.00	0.00	0.00		4	0	0.00	0.00	0.00
	5	0	0.00	0.00	0.00		5	0	0.00	0.00	0.00
	6	0	0.00	0.00	0.00		6	0	0.00	0.00	0.00
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	42.16					Total	11.53
44	0	25	0.96	-23.11	11.10	45	0	24	0.93	-22.28	10.72
	1	1	0.04	-0.86	0.40		1	2	0.07	-1.60	0.71
	2	0	0.00	-0.03	0.03		2	0	0.00	-0.12	0.12
	3	0	0.00	0.00	0.00		3	0	0.00	0.00	0.00
	4	0	0.00	0.00	0.00		4	0	0.00	0.00	0.00
	5	0	0.00	0.00	0.00		5	0	0.00	0.00	0.00
	6	0	0.00	0.00	0.00		6	0	0.00	0.00	0.00
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	11.53					Total	11.56
46	0	24	0.93	-22.28	10.72	47	0	24	0.86	-18.80	8.26
	1	2	0.07	-1.60	0.71		1	0	0.13	-6.73	6.73
	2	0	0.00	-0.12	0.12		2	2	0.01	1.55	5.27
	3	0	0.00	0.00	0.00		3	0	0.00	-0.02	0.02
	4	0	0.00	0.00	0.00		4	0	0.00	0.00	0.00
	5	0	0.00	0.00	0.00		5	0	0.00	0.00	0.00
	6	0	0.00	0.00	0.00		6	0	0.00	0.00	0.00
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	11.56					Total	20.27

Shows significance $P = 0.01$(<18.48) and $P = 0.05$(<14.07) and hypothesis accepted

respectively. Chi-square analysis shows that during those weeks the calculated value is less than the table value showed non-significant results at 5% (14.07) and 10% (18.48) levels. It make known that the hypothesis of binomial distribution at 40^{th}, 40^{st}, 43^{rd}, 44^{th}, 45^{th} and 46^{th} standard weeks are a good fit. The average weekly rainfall distribution indicates very high positive value of coefficient of correlation (Chand *et al*., 2011).

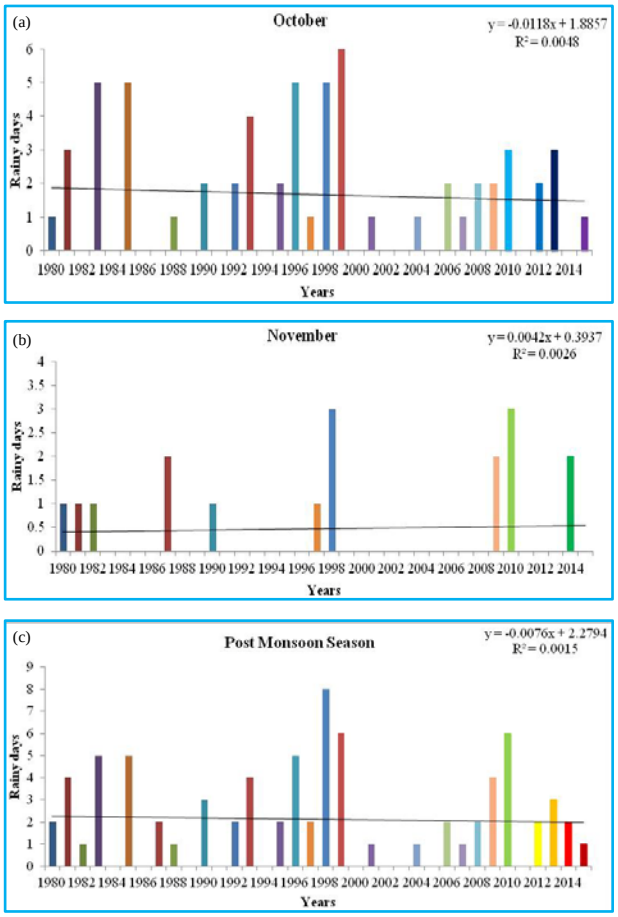
3.5.3. *Normal distribution*

On the basis of past 26 years of monsoon season rainfall data of Bharuch district, reveals that the normal distribution at 10, 20 and 30% probability levels for the month of June, the possibility of occurrence of minimum rainy days are 8, 7 and 6 respectively. The normal rainy days in a month of June are 5. Analysis of normal

TABLE 6

Analysis accordingly normal distribution of occurrence of rainy days at different probability levels against normal for Bharuch district

Probability Levels (*X*)	Months						Seasons	
	Jun	Jul	Aug	Sep	Oct	Nov	Monsoon	Post monsoon
0.10	8	15	14	11	4	4	37	4
Different percentage with normal rainy days	97.06	82.82	87.91	104.79	238.15	358.46	71.54	201.65
0.20	7	13	12	9	3	2	36	3
Different percentage with normal rainy days	80.78	75.25	79.29	91.39	157.56	224.14	68.96	138.88
0.30	6	13	12	9	2	2	35	2
Different percentage with normal rainy days	74.30	72.24	75.87	86.06	125.49	170.70	67.93	113.91
Normal rainy days	5	11	10	7	1	0	34	1



Figs. 6(a-c). Monthly and Post monsoon season variability and trend at Valsad district

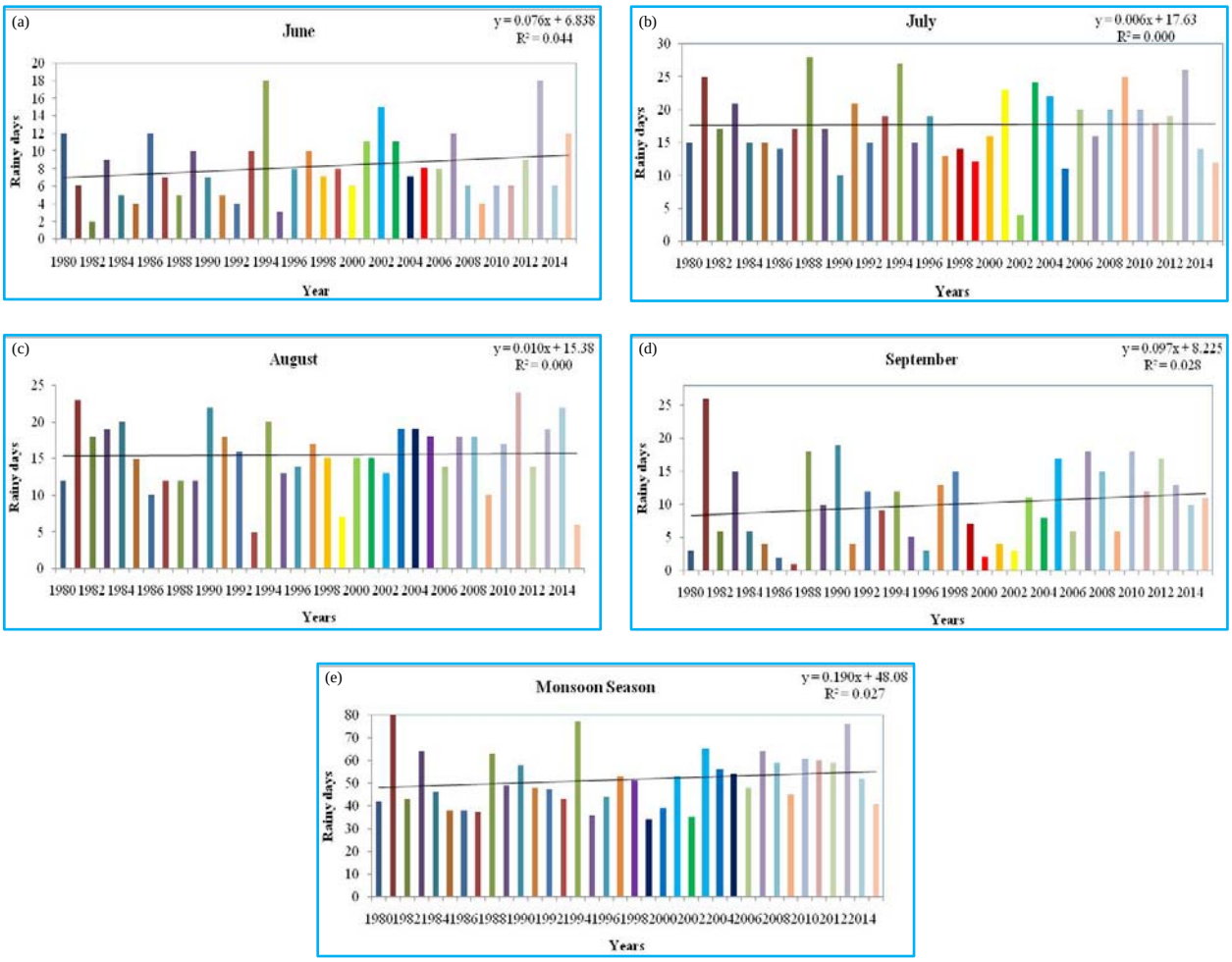
distribution at 10, 20 and 30% probability levels acknowledges that the rainy days enhancements in terms of percentage are 97.06, 80.78 and 74.30 respectively. Normal distribution at 10, 20 and 30% probability levels for the month of July, the feasibility of occurrence of minimum rainy days are 15, 13 and 13 respectively. The normal rainy days in a month of July are 11. The rainy days enrichment in terms of percentage is 82.82, 75.25 and 72.24 respectively. The month of August the possibility of occurrence of minimum rainy days are 14, 12 and 12 respectively. The normal rainy days in a month of August are 10. The rainy days enhancement in terms of percentage is 87.91, 79.29 and 75.87 respectively. Similarly for the month of September the possibility of occurrence of minimum rainy days are 11, 9 and 9 respectively. The normal rainy days in a month of September are 7. The rainy days enrichment in terms of percentage is 104.79, 91.39 and 86.06 respectively.

The rainy days analysis of normal distribution at 10, 20 and 30% probability levels for the monsoon season the possibility of occurrence of minimum rainy days are 37, 36 and 35 respectively, with normal rainy days are 34. Analysis of normal distribution at 10, 20 and 30% probability levels the rainy days enhancement in terms of percentage is71.54, 68.96 and 67.93 respectively. In case of post monsoon season the possibility of occurrence of minimum rainy days is 4, 3 and 2 respectively with normal rainy days is 1. Analysis of normal distribution at 10, 20 and 30% probability levels affirms that the rainy days enhancement in terms of percentage are 201.65, 138.88 and 113.91 respectively (Table 6).

3.5.4. *Trend in monsoon season*

3.5.4.1. *June*

The normal rainy days of June month are 5. The trend analysis conceded significant increase in rainy days trend with an annual rate of 0.021 per year. Trend analysis equation is $y = 0.021x + 4.473$ with R^2 0.002 Fig. 3(a).



Figs. 7 (a-e). Monthly and monsoon season variability and trend at Navsari

3.5.4.2. *July*

From Fig. 1(b), data revealed that normal rainy days of July month are 11. The trend analysis divulged significant decreasing in rainy days trend with an annual rate of -0.041 per year. Trend analysis equation is y = -0.041x + 12.02 with R^2 0.003. Fig. 3(b).

3.5.4.3. *August*

The normal rainy days of August month are 10. The trend analysis notified significant decreasing in rainy days trend with an annual rate of -0.046per year. Trend analysis equation is y = -0.046x + 11.08 with R^2 0.003 Fig. 3(c).

3.5.4.4. *September*

Ten normal rainy days are found in September month and significantly increasing trend of rainy days was found with an annual rate of 0.123 per year. Trend analysis equation is y = 0.123x + 5.603 with R^2 0.028 Fig. 3(d).

3.5.4.5. *Monsoon season*

The normal rainy days of monsoon season are 34. The trend analysis acknowledged significant increase in rainy days with an annual rate of 0.057 per season. Trend analysis equation is y = 0.057x + 33.19 with R^2 0.001 Fig. 3(e).

3.5.5. *Trend in post monsoon season*

3.5.5.1. *October*

The normal rainy days of October month are 1. The trend analysis affirmed significant decrease in rainy days with an annual rate of -0.023 per year. Trend analysis equation is y = -0.023x + 1.049 with R^2 0.018 Fig. 4(a).

TABLE 7

Rainy days analysis concerning binomial distribution for monsoon season of Valsad district

Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$	Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$
22	0	26	0.61	-4.66	0.71	23	0	16	0.24	4.21	1.50
	1	7	0.31	-8.53	4.68		1	5	0.38	-13.92	10.24
	2	0	0.07	-3.37	3.37		2	6	0.26	-7.01	3.78
	3	2	0.01	1.59	6.25		3	6	0.10	1.03	0.21
	4	1	0.00	0.97	32.05		4	3	0.02	1.86	3.04
	5	0	0.00	0.00	0.00		5	0	0.00	-0.16	0.16
	6	0	0.00	0.00	0.00		6	0	0.00	-0.01	0.01
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	47.07					Total	18.94
24	0	6	0.03	4.33	11.28	25	0	3	0.02	2.14	5.34
	1	9	0.15	1.70	0.40		1	5	0.09	0.27	0.02
	2	1	0.27	-12.70	11.77		2	10	0.22	-1.17	0.12
	3	9	0.29	-5.28	1.96		3	3	0.29	-11.66	9.27
	4	5	0.18	-3.94	1.74		4	7	0.23	-4.54	1.79
	5	0	0.07	-3.36	3.36		5	1	0.11	-4.45	3.63
	6	3	0.01	2.30	7.55		6	5	0.03	3.57	8.91
	7	3	0.00	2.94	137.83		7	2	0.00	1.84	21.03
				Total	175.89					Total	50.11
26	0	2	0.01	1.71	9.89	27	0	3	0.00	2.96	218.83
	1	5	0.04	2.77	3.44		1	1	0.01	0.50	0.51
	2	4	0.14	-3.24	1.45		2	3	0.05	0.37	0.05
	3	6	0.26	-7.07	3.82		3	5	0.16	-2.76	0.98
	4	7	0.28	-7.15	3.61		4	3	0.27	-10.73	8.39
	5	5	0.18	-4.19	1.91		5	7	0.29	-7.57	3.94
	6	2	0.07	-1.32	0.52		6	6	0.17	-2.60	0.78
	7	5	0.01	4.49	39.25		7	8	0.04	5.83	15.63
				Total	63.90					Total	249.12
28	0	1	0.00	0.99	65.23	29	0	0	0.00	-0.01	0.01
	1	0	0.00	-0.23	0.23		1	3	0.00	2.82	43.11
	2	5	0.03	3.50	8.18		2	1	0.03	-0.28	0.06
	3	4	0.11	-1.47	0.39		3	4	0.10	-0.93	0.18
	4	5	0.24	-6.98	4.06		4	5	0.23	-6.42	3.61
	5	5	0.31	-10.74	7.32		5	9	0.32	-6.87	2.97
	6	6	0.23	-5.49	2.62		6	4	0.25	-8.25	5.56
	7	10	0.07	6.41	11.42		7	10	0.08	5.95	8.73
				Total	99.46					Total	64.23
30	0	1	0.00	1.00	582.57	31	0	0	0.00	-0.01	0.01
	1	0	0.00	-0.04	0.04		1	3	0.00	2.85	55.41
	2	0	0.01	-0.40	0.40		2	2	0.02	0.92	0.78
	3	4	0.04	1.76	1.38		3	3	0.09	-1.42	0.45
	4	3	0.15	-4.49	2.70		4	5	0.22	-5.83	3.14
	5	7	0.30	-8.04	4.30		5	7	0.32	-8.93	5.01
	6	12	0.34	-4.77	1.36		6	4	0.26	-9.02	6.25
	7	9	0.16	0.99	0.12		7	12	0.09	7.44	12.13
				Total	592.87					Total	83.18
32	0	0	0.00	0.00	0.00	33	0	0	0.00	-0.03	0.03
	1	1	0.00	0.94	13.67		1	1	0.01	0.64	1.11
	2	2	0.01	1.42	3.51		2	3	0.04	0.89	0.38
	3	1	0.06	-1.88	1.23		3	6	0.14	-0.79	0.09
	4	5	0.17	-3.65	1.54		4	9	0.26	-4.10	1.28
	5	10	0.31	-5.57	1.99		5	4	0.30	-11.17	8.22
	6	8	0.31	-7.57	3.68		6	6	0.20	-3.76	1.45
	7	9	0.13	2.33	0.81		7	7	0.05	4.31	6.90
				Total	26.44					Total	19.46

Shows significance $P = 0.01$(<18.48) and $P = 0.05$(<14.07) and hypothesis accepted

TABLE 7 (*Contd.*)

Rainy days analysis concerning binomial distribution for monsoon season of Valsad district

Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$	Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$
	0	1	0.00	0.93	12.94		0	2	0.00	1.82	18.13
	1	4	0.01	3.26	14.37		1	5	0.03	3.43	7.50
	2	4	0.07	0.51	0.08		2	3	0.12	-2.79	1.35
	3	5	0.18	-4.13	1.87		3	6	0.24	-5.87	2.91
34	4	2	0.29	-12.35	10.63	35	4	4	0.29	-10.61	7.70
	5	6	0.27	-7.53	4.19		5	5	0.22	-5.78	3.10
	6	9	0.14	1.91	0.51		6	8	0.09	3.58	2.90
	7	5	0.03	3.41	7.30		7	3	0.02	2.22	6.36
				Total	51.89					Total	49.94
	0	1	0.01	0.49	0.46		0	6	0.03	4.74	17.76
	1	4	0.07	0.68	0.14		1	4	0.12	-2.11	0.73
	2	9	0.18	-0.19	0.00		2	6	0.25	-6.68	3.52
	3	5	0.28	-9.15	5.91		3	6	0.29	-8.60	5.07
36	4	7	0.26	-6.07	2.82	37	4	7	0.20	-3.10	0.95
	5	6	0.14	-1.24	0.21		5	3	0.08	-1.19	0.34
	6	2	0.04	-0.23	0.02		6	2	0.02	1.04	1.11
	7	2	0.01	1.71	9.89		7	2	0.00	1.90	38.07
				Total	19.47					Total	67.55
	0	6	0.08	1.95	0.94		0	15	0.13	8.33	10.39
	1	10	0.25	-2.25	0.41		1	4	0.31	-11.57	8.60
	2	6	0.32	-9.87	6.14		2	5	0.31	-10.57	7.18
	3	7	0.23	-4.42	1.71		3	4	0.17	-4.65	2.50
38	4	5	0.10	0.07	0.00	39	4	3	0.06	0.12	0.00
	5	0	0.03	-1.28	1.28		5	5	0.01	4.42	33.92
	6	1	0.00	0.82	3.62		6	0	0.00	-0.06	0.06
	7	1	0.00	0.99	86.14		7	0	0.00	0.00	0.00
				Total	100.24					Total	62.66

Shows significance $P = 0.01$(<18.48) and $P = 0.05$(<14.07) and hypothesis accepted

3.5.5.2. *November*

The normal rainy days of November month are 0.5. The trend analysis conceded significant decrease in rainy days with an annual rate of -0.003 per year. Trend analysis equation is $y = -0.003x + 0.387$ with R^2 0.000 Fig. 4(b).

3.5.5.3. *Post monsoon*

The normal rainy days of post monsoon season are 1. The trend analysis divulged significant decrease in rainy days with an annual rate of -0.026 per year. Trend analysis equation is $y = -0.026x + 1.436$ with R^2 0.015 Fig. 4(c). (Mohapatra, 2002) was reported that rainfall rising trend during monsoon and falling trend during post monsoon. Similar result was found (Kumar *et al.*, 2015-I).

3.6. *Binomial distribution of Valsad*

3.6.1. *Monsoon season*

Monsoon season runs from June to September and brings rainfall to Valsad district. The weather conditions all over the Valsad district change with the onset of the monsoon winds. High heat, high humidity, extensive clouding and several spells of moderate to heavy rain with strong surface winds are the chief characteristics of this season. In monsoon season of Valsad, analysis of the standard weekly rainy days by binomial distribution on the basis of past 36 years data of rainfall. The result shows that the highest value (592.87) of chi-square test on binomial distribution was found in standard week (SW) 30. In this week the number of rainy days 0, 1, 2, 3, 4, 5, 6

TABLE 8

Rainy days analysis concerning binomial distribution for post monsoon season of Valsad district

Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$	Standard Weeks	x_i	n_i	P	e_i	$\frac{(n_i - e_i)^2}{e_i}$
40	0	16	0.35	-1.55	0.14	41	0	22	0.45	-0.62	0.02
	1	9	0.40	-10.82	5.91		1	7	0.38	-12.00	7.58
	2	8	0.19	-1.59	0.26		2	3	0.14	-3.84	2.16
	3	2	0.05	-0.58	0.13		3	2	0.03	0.63	0.29
	4	1	0.01	0.58	0.82		4	2	0.00	1.84	20.53
	5	0	0.00	-0.04	0.04		5	0	0.00	-0.01	0.01
	6	0	0.00	0.00	0.00		6	0	0.00	0.00	0.00
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	7.30					Total	30.59
42	0	31	0.71	-4.53	0.58	43	0	32	0.73	-4.58	0.57
	1	2	0.25	-10.44	8.76		1	2	0.23	-9.69	8.03
	2	0	0.04	-1.87	1.87		2	0	0.03	-1.60	1.60
	3	2	0.00	1.84	21.89		3	0	0.00	-0.12	0.12
	4	1	0.00	0.99	126.66		4	1	0.00	0.99	177.95
	5	0	0.00	0.00	0.00		5	1	0.00	1.00	6568.78
	6	0	0.00	0.00	0.00		6	0	0.00	0.00	0.00
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	159.75					Total	6757.06
44	0	33	0.89	-11.70	3.06	45	0	32	0.82	-9.05	2.00
	1	2	0.10	-3.05	1.84		1	1	0.16	-7.21	6.33
	2	1	0.00	0.76	2.34		2	3	0.01	2.30	7.49
	3	0	0.00	-0.01	0.01		3	0	0.00	-0.03	0.03
	4	0	0.00	0.00	0.00		4	0	0.00	0.00	0.00
	5	0	0.00	0.00	0.00		5	0	0.00	0.00	0.00
	6	0	0.00	0.00	0.00		6	0	0.00	0.00	0.00
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	7.25					Total	15.85
46	0	33	0.87	-10.46	2.52	47	0	33	0.87	-10.46	2.52
	1	2	0.12	-4.16	2.81		1	1	0.12	-5.16	4.32
	2	0	0.01	-0.37	0.37		2	2	0.01	1.63	7.07
	3	1	0.00	0.99	77.28		3	0	0.00	-0.01	0.01
	4	0	0.00	0.00	0.00		4	0	0.00	0.00	0.00
	5	0	0.00	0.00	0.00		5	0	0.00	0.00	0.00
	6	0	0.00	0.00	0.00		6	0	0.00	0.00	0.00
	7	0	0.00	0.00	0.00		7	0	0.00	0.00	0.00
				Total	82.97					Total	13.92

Shows significance $P = 0.01$(<18.48) and $P = 0.05$(<14.07) and hypothesis accepted

and 7 were observed 1, 0, 0, 4, 3, 7, 12 and 9 times respectively, followed by chi-square value (249.12) in SW 27 and chi-square value (175.89) in SW 24. During SW 22nd to 39th the calculated value is more than the table value and therefore the hypothesis showed significant results at 5% (14.07) and 10% (18.48) probability levels. It acknowledges that the hypotheses of binomial distribution at all standard weeks are not a good fit

Table 7. Distribution fitting is the procedure of selecting a statistical distribution that best fits to a data set generated by some random process.

3.6.2. *Post-monsoon season*

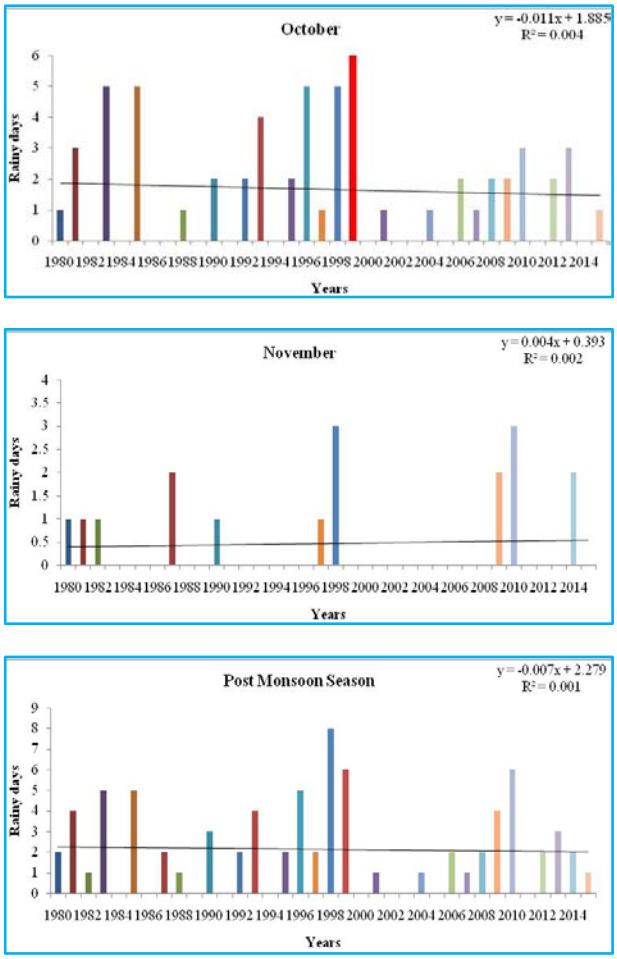
The highest value (6757.06) of chi-square test on binomial distribution was found in standard week (SW) 43. In SW 43 the number of rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were observed 32, 2, 0, 0, 1, 1, 0 and 0 time respectively, followed by chi-square value (159.75) in SW 42. In SW 42 the number of rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were observed 31, 2, 0, 2, 1, 0, 0 and 0 times respectively.

In SW 46th number of rainy days 0, 1, 2, 3, 4, 5, 6 and 7 were observed 33, 2, 0, 1, 0, 0, 0 and 0 times respectively with chi-square value (82.97). Chi-square analysis affirms that during SW weeks 41, 42, 43 and 46, the calculated value is more than the table value and therefore the hypothesis shows significant results at 5% (14.07) and 10% (18.48) probability levels. It concedes that the hypotheses of binomial distribution at those standard weeks are not a good fit in post monsoon season, (Table 5).

The values 7.30, 7.25, 15.85 and 13.92 (Table 8) of chi-square test on binomial distribution were observed in standard weeks 40th, 44th, 45th and 47th respectively. Chi-square analysis divulges that during (40th, 44th, 45th and 47thweeks) the calculated value is less than the table value showed non-significant results at 5% (14.07) and 10% (18.48) levels. It notifies that the hypotheses of binomial distribution in 40th, 44th, 45th and 47th standard weeks are a good fit. The average weekly rainfall distribution indicates very high positive value of coefficient of correlation (Chand *et al*., 2011). Similar result was found probability distribution function has been fitted for the region estimation of climate change in extreme rainfall series of each station.

3.6.3. *Normal distribution*

At Valsad district past 26 years of monsoon season rainfall data make known that the normal distribution at 10, 20 and 30% probability levels for the month of June, the possibility of occurrence of minimum rainy days are 14, 12 and 12 respectively. The normal rainy days in a month of June are 10. Analysis of normal distribution at 10, 20 and 30% probability levels shows that the rainy days enhancements in terms of percentage are 165.52, 149.23 and 142.76 respectively. Normal distribution at 10, 20 and 30% probability levels for the month of July, the feasibility of occurrence of minimum rainy days are 25, 24 and 23 respectively. The normal rainy days in a month



Figs. 8(a-c). Monthly and Post monsoon season variability and trend at Navsari district

of July are 22. The rainy days enrichment in terms of percentage is 140.15, 132.59 and 129.58 respectively. The month of August the possibility of occurrence of minimum rainy days are 24, 22 and 22 respectively. The normal rainy days in a month of August are 21. The rainy days enhancement in terms of percentage is 152.51, 143.89 and 140.46 respectively. Similarly for the month of September the possibility of occurrence of minimum rainy days are 14, 13 and 12 respectively. The normal rainy days in a month of September are 11. The rainy days enhancement in terms of percentage is 142.82, 129.43 and 124.10 respectively.

In case of Monsoon season, the rainy days analysis of normal distribution at 10, 20 and 30% probability levels for the possibility of occurrence of minimum rainy days are 67, 66 and 65 respectively, with normal rainy days are 64. Analysis of normal distribution at 10, 20 and 30% probability levels the rainy days enhancement in terms of percentage is 128.66, 126.08 and 125.05

TABLE 9

Analysis accordingly normal distribution of occurrence of rainy days at different probability levels against normal for Valsad district

Probability Levels (*X*)	Months						Seasons	
	Jun	Jul	Aug	Sep	Oct	Nov	Monsoon	Post monsoon
0.10	14	25	24	14	6	4	67	6
Different percentage with normal rainy days	165.52	140.15	152.51	142.82	337.64	379.40	128.66	288.92
0.20	12	24	22	13	4	2	66	5
Different percentage with normal rainy days	149.23	132.59	143.89	129.43	257.05	245.08	126.08	226.15
0.30	12	23	22	12	4	2	65	4
Different percentage with normal rainy days	142.76	129.58	140.46	124.10	224.98	191.64	125.05	201.18
Normal rainy days	10	22	21	11	2	1	64	3

respectively. In post monsoon season the possibility of occurrence of minimum rainy days is 6, 5 and 4 respectively with normal rainy days is 3. Analysis of normal distribution at 10, 20 and 30% probability levels admits that the rainy days enhancement in terms of percentage is 288.92, 226.15 and 201.18, respectively, (Table 9).

3.6.4. *Trend in monsoon season*

3.6.4.1. *June*

The normal rainy days of June month are 8. The trend analysis acknowledged significant increase in rainy days trend with an annual rate of 0.076 per year. Trend analysis equation is $y = 0.076x - 144.2$ with R^2 0.044, Fig. 5(a).

3.6.4.2. *July*

From Fig. 5(b), it can be showed that normal rainy days of July month are 18. The trend analysis admitted significant increasing in rainy days trend with an annual rate of 0.006 per year. Trend analysis equation is $y = 0.006x + 5.667$ with R^2 0.000, Fig. 5(b).

3.6.4.3. *August*

The normal rainy days of August month are 16. The trend analysis affirmed significant increasing in rainy days trend with an annual rate of 0.010per year. Trend analysis equation is $y = 0.010x - 6.268$ with R^2 0.000, Fig. 5(c).

3.6.4.4. *September*

Ten normal rainy days are found in September month and significantly increasing trend of rainy days was found with an annual rate of 0.097 per year. Trend analysis equation is $y = 0.097x - 184.5$ with R^2 0.028, Fig. 5(d).

3.6.4.5. *Monsoon season*

The normal rainy days of monsoon season are 64. The trend analysis uttered significant increase in rainy days with an annual rate of 0.190 per season. Trend analysis equation is $y = 0.190x - 329.3$ with R^2 0.027, Fig. 5(e).

3.6.5. *Trend in post monsoon season*

3.6.5.1. *October*

The normal rainy days of October month are 2. The trend analysis notified significant decrease in rainy days with an annual rate of -0.011 per year. Trend analysis equation is $y = -0.011x + 25.31$ with R^2 0.004, Fig. 6(a).

3.6.5.2. *November*

The normal rainy days of November month are 0.5. The trend analysis explained significant increase in rainy days with an annual rate of 0.004 per year. Trend analysis equation is $y = 0.004x - 8.001$ with R^2 0.002, Fig. 6(b).

3.6.5.3. *Post monsoon*

The normal rainy days of post monsoon season are 2. The trend analysis conceded significant decrease in rainy days with an annual rate of -0.007 per year. Trend analysis equation is $y = -0.007x + 17.30$ with R^2 0.001, Fig. 6(c). Similar result was reported (Kumar *et al*., 2015-I) and (Mohapatra, 2002) was reported that rainfall rising trend during monsoon & falling trend during post monsoon.

The state receives rain under the influence of South west monsoon only during the four month from June to September. However, the onset, withdrawal and duration of monsoon are not uniform throughout the state. In south Gujarat, the monsoon commences from the middle of June and lasts up to end of October, while in north Gujarat in state a little latter and end by about the middle of September. In Saurashtra region, it commences from second week of June and lasts up to second week of September. The India Meteorological department views Gujarat state as two sub-divisions, Gujarat region and Saurashtra - Kutch region. The state's annual average rainfall is about 820 mm received in 30 rainy days. The annual average rainfall Gujarat region 970 mm received in 43 rainy days, while that of Saurashtra - Kutch region is only 580 mm received in an average in only 23 rainy days. The coefficient of variation (CV%) of rainfall for Gujarat region is 23% and that of Saurashtra- Kutch is 35 percent. Considering Bharuch - Deesa line, the rainfall in the state decreases towards west of the line (Sahu, 2007).

4. Conclusions

The standard weekly rainy days analysis of binomial distribution for monsoon season of Navsari on chi-square test on binomial distribution was found in SW 22 to 31, 33 and SW 35 to 39 and post monsoon in standard week (SW) 41 to 44 shows significant. The result also reveals that the monsoon season SW 32 and 34 and post monsoon season SW 40, 45, 46 and 47 revealed non-significant result. Analysis reveals the rainfall is not equally distributed during SW 32, 34, 40, 45, 16 and 47, so that the test of binomial distribution is a good fit. Monsoon season rainfall data of Navsari, Bharuch and Valsad reveals that the normal distribution at 10, 20 and 30 % probability levels for the month of June, July, August and September shows the possibility of increasing rainy days occurrence. The Navsari and Bharuch districts during post monsoon season rainfall of months of October and November reveals decreasing tendency except Valsad district. The binomial distribution fit only those standard weeks in which rainfall is not equally distributed. The frequency distribution is workout for monsoon (22 to 39 standard weeks) and post monsoon (40 to 47 standard weeks) seasons. The standard weekly rainy days analysis of binomial distribution on chi-square test in Bharuch was found that standard week (SW) 25 only 10% of monsoon season and in post monsoon standard week (SW) 42 and 47 shows non significant (5 and 10% level of significant) result, but SW 25 found significant at 5% level. In case of Valsad district, standard week 22 to 39 of monsoon season and in post monsoon season 41, 42, 43 and 46 standard weeks shows significant result. The result reveals that the monsoon season of Bharuch standard weeks 22 to 39 except from 25 and post monsoon 40, 41, 43, 44, 45 and 46 shows significant result. Further, in Valsad district standard weeks 40, 44, 45 and 47 shows significant result. From above results observed that the rainfall distribution is not equally distributed so test of binomial distribution at above given standard week is a good fit. The trend analysis of rainy days shows that increasing trend in monsoon season and decreasing trend in post monsoon season of Navsari, Bharuch and Valsad districts. On the basis of these finding the result reveals that during monsoon season favorable condition for agriculture crops was observed at Navsari, Bharuch and Valsad districts. The data also shows that, decreasing tendency in rainfall was observed except Valsad district.

Disclaimer : The contents and views expressed in this study are the views of the authors and do not necessarily reflect the views of the organizations they belong to.

References

Basu, G. C., Bhattacharjee, U. and Ghosh, R., 2004, "Statistical analysis of rainfall distribution and trend of rainfall anomalies district wise during monsoon period over West Bangal", *MAUSAM*, **55**, 3, 409-418.

Ben-Gai, T., Bitan, A., Manes, A., Alpert, P. and Rubin, S., 1998, "Spatial and Temporal Changes in Rainfall Frequency Distribution Patterns in Israel", *Theor. Appl. Climatol.*, **61**, 177-190.

Chand, R., Singh, U. P., Siddique, L. A. and. Kore, P. A., 2011, "Analysis of weekly rainfall of different period during rainy season over safdajung airport of Delhi for 20th century - A study on trend, decile and decadal analysis", *MAUSAM*, **62**, 2, 197-204.

Chandrawanshi, S. K., Bobade, P., Chaudhary, J. L., Manikandan, N. and Patel, S. R., 2017, "To examine the standardized precipitation index trend by using Mann Kendal non parametric test during pre and post global warming behind in a future climate in Chhattisgarh", *Bulletin of Environment, Pharmacology and Life science*, **6**, (4 Special issue), 507-516.

Guhathakurta, P., Menon, P. A., Dikshit, S. K. and Sable, S. T., 2005, "Extreme rainfall of Andhra Pradesh using a probability distribution model : A regional estimate", *MAUSAM*, **56**, 4, 785-794.

Jaswal, A. K. and Rao, G. S. P., 2010, "Recent trends in meteorological parameters over Jummu and Kashmir", *MAUSAM*, **61**, 3, 369-382.

Jaswal, A. K., Bhan, S. C., Karandikar A. S. and Gujar, M. K., 2015, "Seasonal and annual rainfall trends in Himachal Pradesh during 1951-2005", *MAUSAM*, **66**, 2, 247-264.

Joshi, U. R., Dube, R. K. and Rao, P. G. S., 2005, "Trend in precipitation Extremes over India", National Climate Center Research Repost 3.

Kumar, N., Panchal, C. C., Chandrawanshi, S. K. and Thanki, J. D., 2017, "Analysis of rainfall by using Mann-Kendall trend, Sen's slope and variability at five districts of south Gujarat, India", *MAUSAM*, **68**, 2, 205-222.

Kumar, N., Patel, S. S., Chalodia, A. L., Vadaviya, O. U. , Pandya, H. R., Pisal, R. R., Dakhore, K. K. and Patel, M. L., 2015-II,

"Markov Chain and Incomplete Gamma distribution analysis of weekly rainfall over Navsari region of South Gujarat", *MAUSAM*, **66**, 4, 751-760.

Kumar, N., Pisal, R. R., Shukla, S. P. and Patel, S. S., 2015-I, "Analysis of climatic variability at heavy rainfall zone of South Gujarat", *MAUSAM*, **66**, 40, 850-856.

Kumar, R. K., Pant, G. B., Parthasarathy, B. and Sontakke, N. A., 1992, "Spatial and subseasonal patterns of the longterm trends of Indian summer monsoon rainfall", *Internation J. Climatology*, **12**, 257-268.

Lettenmaier, D. P., Wood, E. F. and Wallis, J. R., 1994, "Hydro-climatological trends in the continental United States 1948-88", *J. Clim.*, **7**, 586-607.

Lunagaria, M. M., Dabhi, H. P. and Pandey V., 2015, "Trend in the temperature and rainfall extremes during recent past in Gujarat", *Journal of Agrometeorology*, **17**, 1, 118-123.

Manikandan, N. Rani, B. A. and Satyamoorthi, K., 2014, "Weekly rainfall variability and probability analysis for Coimbatore in respect of crop planning", *MAUSAM*, **65**, 3, 353-356.

Mohapatra, M., 2002, "Recent trends in climate of Banglore", *MAUSAM*, **54**, 4, 425-438.

Ray, K., Mohanty, M. N. A., Chincholikar, J. R., 2009, "Climate variability over Gujarat, India", ISPRS Archivers XXXVIII-8/W3 Workshop Proceedings : *Impact of Climate change on Agriculture*.

Sahu, D. D., 2007, Text book of Agrometeorology and remote sensing principles and practices. 43-44.

Seetharam, K., 2010, "Rainfall models-a study over Gangtok", *MAUSAM*, **61**, 2, 225-228.

Sen, Z. and Eljadid, A. G., 1999, "Rainfall distribution function for Libya and rainfall prediction", *Hydrological Sciences Journal*, **44**, 5, 665-680.