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Research Article

Rainy Days Analysis by Using Statistical Methods for Valsad District of South Gujarat

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ABSTRACT

Monsoon season rainfall data of 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 valsad districts during post monsoon season rainfall of months of October and November reveals increasing tendency. 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. However, 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. On the basis of these finding the result reveals that during monsoon season favorable condition for agriculture crops was observed at Valsad districts.

Keywords: *Rainy day analysis, Discrete probability, Gaussian distributions, Trend analysis.*

INTRODUCTION

Valsad is situated in the south zone of Gujarat state at 22.35° N and 72.35°E, Altitude 6.10 m above the mean sea level. A district receives much of its rainfall from the south-west monsoon during the period between June & September; its maximum intensity being in the month of July & August. The region receives 1500-1903.2 mm of annual rainfall with 40-55 rainy days. Valsad district is located in south of tropic of Cancer, comes under heavy rainfall areas of South Gujarat, having sub-tropical climate with moderately high humidity. The main seasons prevailing in the district are (a) monsoon - mid of June to October, (b) winter - November to February, and (c) summer – March to June. The district has varied agriculture crops, both food crops, horticulture & non food crops.

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Main food crops consist of food grains such as paddy, wheat, sorghum, pearlmillet, maize and sugarcane etc., and pulses and the horticulture crops being produced in the district are mangoes, cucurbits, chiku, banana & vegetables. Agriculture in this region is highly sensitive to variability of rainfall across time and space resulted in low agricultural production and affected rural poor farmers with serious degradation of the environment. Agriculture and related sectors, food security, and energy security of India are crucially dependent on the timely availability of adequate amount of water and a conducive climate. The rainfall received in an area is an important factor in determining the amount of water available to meet various demands, such as agricultural, industrial, domestic water supply and for hydroelectric power generation. Kumar et al. (1992) examined the trends in the total precipitation during 1871-1984 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. However, increasing incidences of floods, droughts due to erratic weather, it’s a time to explore ways of bringing a sustainable model of farming for our farmers and minimize dependency on monsoon of the monsoon rainfall.

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).

MATERIALS AND METHODS

The present study was carried out by using the 30 years (1986-2015) of daily meteorological data observed at Agro-meteorological observatory, at Valsad district (22.35° N and 72.35°E, Altitude 6.10 m) and this station comes under south Gujarat heavy rainfall zone.

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. The binomial distribution is a theoretical (regular) discrete probability distribution that is mainly used to calculate probabilities in experiments. This distribution arises in Bernoulli processes where in any trial; the event may or may not take place. The probability of occurrence of the event is the same from one trial to another. 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 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, ------- n

x! = 1 x 2 x 3 x ---------- 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

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

a + b = l (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. Normal distributions are extremely important because they occur so often in real applications and they play such an important role in methods of inferential statistics. 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

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

Where,

μ = Population mean

σ = Population standard deviation

‘μ’ is best estimated by $\overline{x}$ and ‘σ’ by‘s’. There are obtained from the sample values by the relationship

$$\overline{x} = \frac{l}{n} \sum_0^n x$$

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

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.

RESULT 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 modelling 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.

3.6 Binomial distribution of Valsad district

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 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 1. 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 46 the 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 2).

The values 7.30, 7.25, 15.85 and 13.92 (Table 2) 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 47th weeks) 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 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 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 3).

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, fig1a.

3.6.4.2 July

From fig.5b, 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.1b.

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 0.010 per year. Trend analysis equation is y = 0.010 x -6.268 with R^2 0.000, fig.1c.

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 = 0.097 x -184.5 with R^2 0.028, fig.1d.

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.1e.

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.2a.

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=2b.

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.6c. 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).

Table 1: 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	26	0.61	-4.66	0.71		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
22	4	1	0.00	0.97	32.05	**23**	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
	0	6	0.03	4.33	11.28		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
24	4	5	0.18	-3.94	1.74	**25**	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
	0	2	0.01	1.71	9.89		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
26	4	7	0.28	-7.15	3.61	**27**	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

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

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	0.99	65.23		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	**29**	3	4	0.10	-0.93	0.18
28	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
	0	1	0.00	1.00	582.57		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	**31**	3	3	0.09	-1.42	0.45
30	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
	0	0	0.00	0.00	0.00		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
32	4	5	0.17	-3.65	1.54	**33**	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

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

Table 2: 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	$\frac{(n_i-e_i)^2}{e_i}$
	0	16	0.35	-1.55	0.14		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
40	4	1	0.01	0.58	0.82	**41**	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
	0	31	0.71	-4.53	0.58		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
42	4	1	0.00	0.99	126.66	**43**	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
	0	33	0.89	-11.70	3.06		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
44	4	0	0.00	0.00	0.00	**45**	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

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

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	33	0.87	-10.46	2.52		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
46	4	0	0.00	0.00	0.00	**47**	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

Table 3: Analysis accordingly normal distribution of occurrence of rainy days at different probability levels against normal for Valsad district

Probability Levels (X)	Months						Seasons	
	June	July	August	September	October	November	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

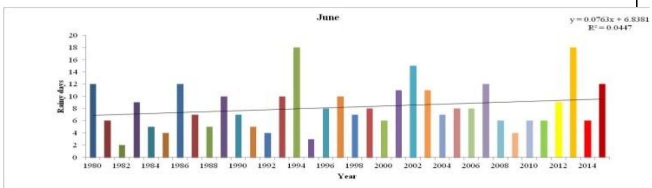


Fig.: 1a

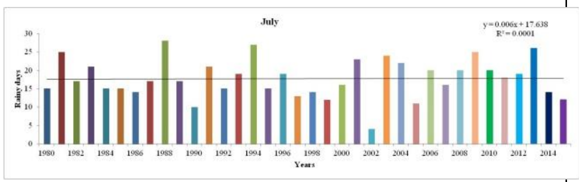


Fig. :1b

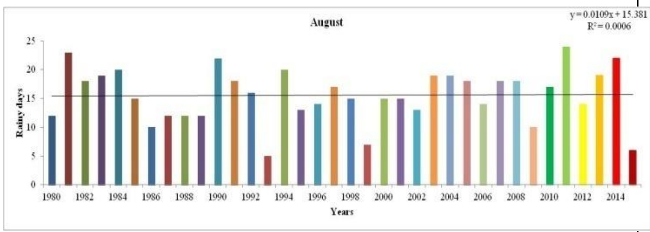
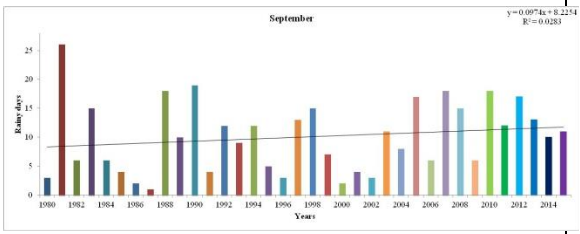


Fig. :1c



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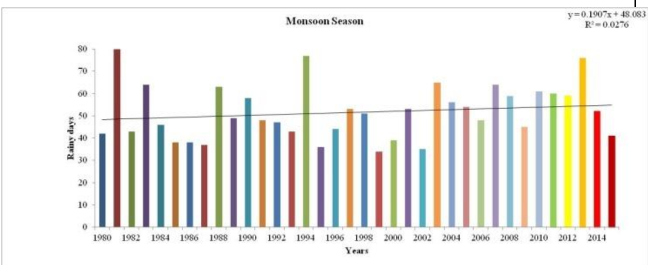

Fig. :1e

Fig.1a-e:-Monthly and monsoon season variability and trend at Valsad district

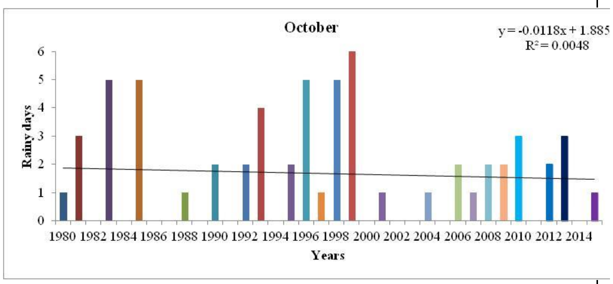

Fig. :2a

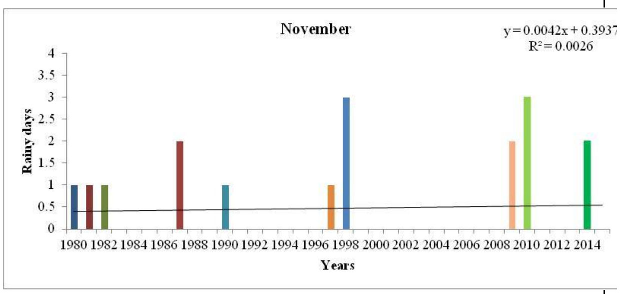

Fig.: 2b

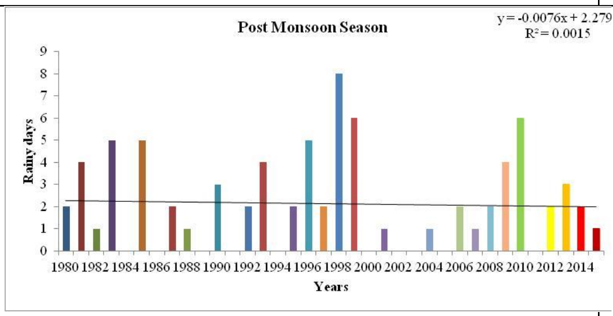

Fig.: 2c

Fig. 2a-c:-Monthly and Post monsoon season variability and trend at Valsad district

CONCLUSION

Monsoon season rainfall data of 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 valsad districts during post monsoon season rainfall of months of October and November reveals increasing tendency. 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. However, 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. 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. On the basis of these finding the result reveals that during monsoon season favorable condition for agriculture crops was observed at Valsad districts. The data also shows that, increasing tendency in rainfall was observed at district.

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