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Probability analysis of rainfall distribution in Sambalpur district of Odisha

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Abstract

The distribution of rainfall has great variation over time. This results in drought, abnormal and normal rainfall in different years. The statistical study of rainfall probability is of utmost importance due to the random nature of rainfall pattern. This study can be of much utility for crop planning. The probability distribution of drought, normal and abnormal rainfall at Sambalpur district in western Odisha is studied monthly and seasonally from rainfall data for period of 24 years (1993-94 to 2016-17). The month having monthly rainfall less than half of mean monthly rainfall is regarded as drought month, more than twice the mean monthly rainfall is regarded as abnormal month and in between half and twice of the mean monthly rainfall is regarded as normal month. The probability of normal rainfall remains high during kharif season (June – September) with very low probability occurrences of drought months. The probability of drought months remains high in rabi season, whereas, in summer season the probability of abnormal months remain high. The C.V. of rainfall is less in months having more rainfall and increases in dry months. December, the driest month is having highest C.V. and August, the wettest month is having second lowest C.V. Thus the wet months are consistent in rainfall and the drier months are having high uncertainty of rainfall.

Keywords: Probability, drought months, normal months, abnormal months

Introduction

The quantity and distribution of rainfall greatly decides the success of agriculture in a region. The random nature of rainfall distribution alongwith its time dependent nature creates a need for its statistical analysis on basis of its probability. Many workers (Sharma *et al.*, 1999, Hooda and Thakur, 1998) [3, 1] have studied the occurrence of drought, normal and abnormal rainfall by using probability approach. Drought and floods are natural disasters and have direct impact on socioeconomic condition of farmers and also on crop production. So, it is very important to examine occurrence of drought, normal and abnormal rainfall of a region. Sambalpur district, situated in western part of Odisha has a tropical climate. Rice is the important crop grown in this district whose production is greatly affected by rainfall pattern. In the study, an effort has been made to study the probability distribution of drought, normal and abnormal months and years at Sambalpur. The seasons are kharif (June – September), Rabi (October- January) and summer (February – May).

Material and Methods

Monthly rainfall data from 1993-94 to 2016-17 has been collected from IMD, Bhubaneswar. The data are arranged monthly and seasonwise. Each month and season has 24 rainfall events corresponding to 24 years. Monthly and seasonal rainfall events were then classified as drought, normal and abnormal.

Determination of drought, normal and abnormal months

Let $K_1 = \frac{\bar{Y}}{2}$; $K_2 = 2\bar{Y}$, where \bar{Y} is the mean monthly rainfall;

If monthly rainfall is less than K_1 , then it is defined as drought month.

If monthly recovery rainfall lies between K_1 and K_2 , then it is defined as normal month.

If monthly recovery rainfall is more than K_2 , then it is defined as abnormal month.

Percentage of drought, normal and abnormal months is given by:

Percentage of drought, normal and abnormal months is given by: (No. of drought, normal and abnormal months / total no. of months in the entire period of study) X 100

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Probability of occurrence of drought, normal and abnormal months is given by

If d_i , n_i and a_i ($i = 1, 2, 12$) are the number of drought, normal and abnormal months, out of total number of drought (D), normal (N) and abnormal (A) months during the entire period of 24 years (1993-94 to 2016-17), then the probability of occurrence of drought, normal and abnormal months are given by: $P(D) = d_i/D$; $P(N) = n_i/N$ and $P(A) = a_i/A$; $i = 1, 2, 3, \dots, 12$.

Calculation of probability of occurrence of drought, normal and abnormal seasons is given by:

If d_i^* , n_i^* and a_i^* ($i = 1, 2, 3$) are the total number of drought, normal and abnormal months in the i th season, the estimated values of probability of occurrence of drought, normal and abnormal months falling in a given season are given by:

$$P(D)^* = d_i^*/D; P(N)^* = n_i^*/N; P(A)^* = a_i^*/A; i = 1, 2, 3$$

The variability in rainfall is studied with the help of Coefficient of variation (Sarkar, *et al*, 2013) [2].

$$\text{C.V. of monthly rainfall} = \frac{\text{Standard Deviation of monthly rainfall}}{\text{Mean monthly rainfall}} \times 100$$

$$\text{C.V. of seasonal rainfall} = \frac{\text{Standard Deviation of seasonal rainfall}}{\text{Mean seasonal rainfall}} \times 100$$

Results and Discussion

The study of monthly rainfall statistics as revealed from Table 1 shows that the month of August has the highest mean monthly rainfall and the month of December has the lowest monthly rainfall. This shows that August is the wettest month and December is the driest month over the period of 24 years (1993-94 to 2016-17). Also from table 1 it is found that the wettest month i.e. August has the lowest C.V. and the driest month i.e. December has the highest C.V. Thus it is seen that there is an inverse relationship between mean and C.V. of monthly rainfall. The frequency of normal months is more in wettest months and the frequency of drought months is more in drier months. The probability of normal months is more in wet months and the probability of drought months is more in drier months. The probability of drought month is highest for the December month and the probability of normal month is highest for the months of July and August. The probability of abnormal month is highest for the month of April.

The study of seasonal rainfall statistics as revealed from Table 3 shows that the C.V. of seasonal rainfall is lowest for Kharif season and highest for rabi season. Thus it is seen that there is an inverse relationship between mean and C.V. of seasonal rainfall. The probability of normal months is more in kharif season and the probability of drought months is more in rabi season.

Table1: Monthly rainfall statistics at Sambalpur district of Odisha

Month	Mean monthly rainfall (in mm)	Mean monthly rainfall as % of mean annual rainfall	S.D.	C.V.	A ₁	A ₂	No. of drought/normal/abnormal months		
							d_i	n_i	a_i
January	18.10	1.19	30.01	165.77	9.05	36.20	16	4	4
February	13.15	0.87	19.06	144.92	6.58	26.30	16	6	2
March	5.99	0.39	6.73	112.34	3.00	11.98	12	6	6
April	19.31	1.28	18.89	97.82	9.65	38.62	8	8	8
May	21.87	1.44	15.92	72.84	10.93	43.74	6	18	0
June	195.88	12.92	103.35	52.77	97.94	391.76	6	16	2
July	435.33	27.71	124.73	28.65	217.66	870.66	2	22	0
August	443.62	28.94	183.78	43.38	211.81	847.24	2	22	0
September	279.52	18.43	172.29	61.64	139.76	559.04	2	20	2
October	71.1	4.69	66.27	93.20	35.55	142.2	4	18	2
November	9.83	0.52	14.77	188.62	3.92	15.66	16	6	2
December	8.87	0.59	18.35	206.86	4.44	17.74	20	0	4
						Total	110	146	32

Table 2: Probability of drought, normal and abnormal months in a year

Month	Drought month		Normal month		Abnormal month	
	P(D)*	Percentage of months having a given month as drought month	P(N)*	Percentage of months having a given month as normal month	P(A)*	Percentage of months having a given month as abnormal month
January	0.15	66.67	0.03	16.67	0.13	16.67
February	0.15	66.67	0.04	25	0.06	8.33
March	0.11	50	0.04	25	0.19	25
April	0.07	33.33	0.05	33.33	0.25	33.33
May	0.05	25	0.12	75	0	0
June	0.05	25	0.11	66.67	0.06	8.33
July	0.02	8.33	0.15	91.67	0	0
August	0.02	8.33	0.15	91.67	0	0
September	0.02	8.33	0.14	83.33	0.06	8.33
October	0.04	16.67	0.12	75	0.06	8.33
November	0.15	66.67	0.04	25	0.06	8.33
December	0.18	83.33	0	0	0.13	16.67

Table 3: Seasonal rainfall statistics and probability of drought, normal and abnormal months in a year

Season	Mean rainfall (inmm)	Mean monthly rainfall as percentage of mean annual rainfall	S.D.	C.V.	Probability		
					P(D*)	P(N*)	P(A*)
Kharif (June-September)	1348.78	88.95	329.26	24.41	0.11	0.51	0.38
Rabi (October-January)	102.07	6.73	77.14	75.58	0.55	0.19	0.26
Summer (February-May)	65.53	4.32	36.18	55.21	0.13	0.38	0.49

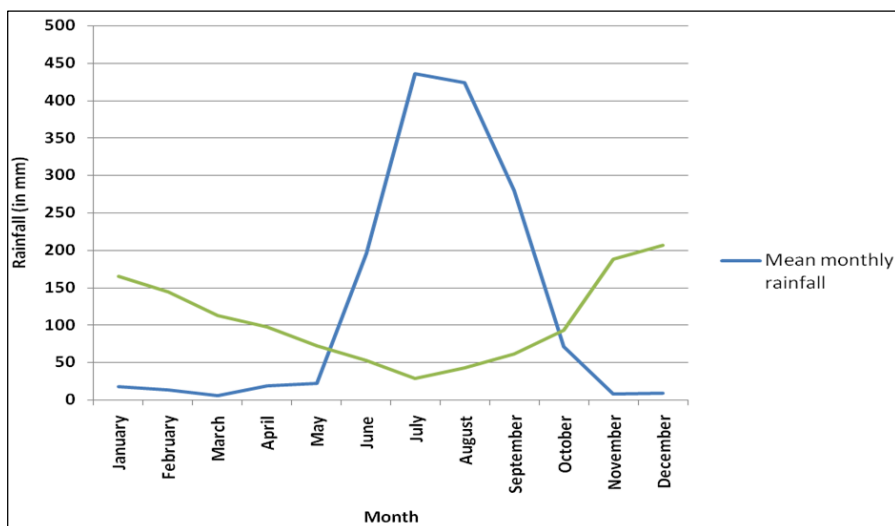


Fig 1: Mean and C.V. of Monthly Rainfall

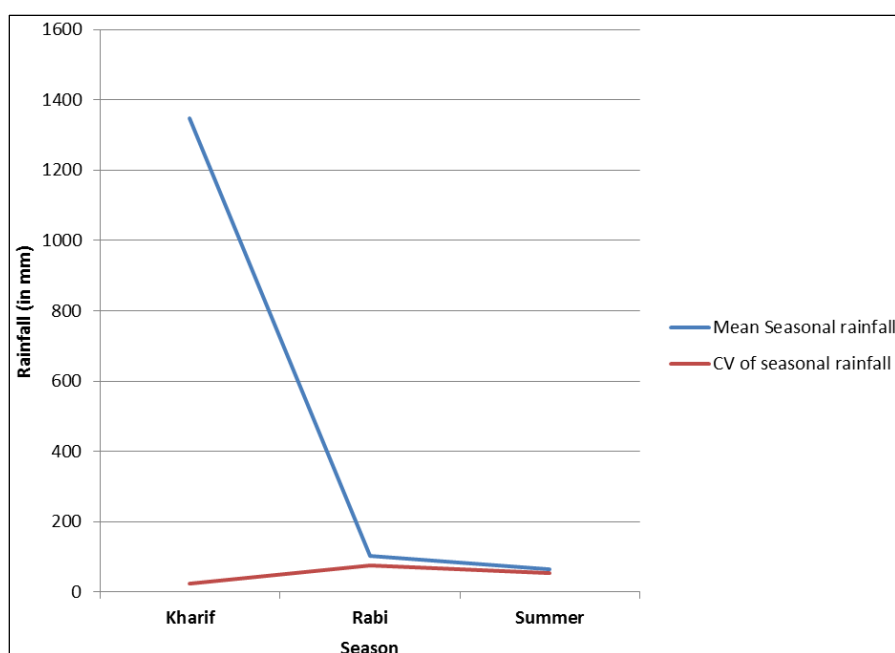


Fig 2: Mean and C.V. of Seasonal Rainfall

Conclusion

It is concluded that the probability of normal months is highest for kharif season, which has highest mean rainfall of 1348.78 mm. Also the rainfall in kharif is much consistent as having low C.V. of 24.41 per cent. The wet months are having low C.V. and thus consistent in their rainfall pattern, whereas the dry months show more variation in their rainfall pattern. This shows an inverse relationship between mean and C.V. of rainfall. (Fig. 1). The amount of rainfall in kharif season contributing 88.95 percent to the mean annual rainfall is sufficient for paddy crop. So, paddy can be taken as the main crop in kharif season in sambalpur district. The probability of normal months is highest for the wet months i.e., July, August and September. The probability of drought months is highest for the dry months of rabi season.

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