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A study of wet spells and persistence of rainy days in Raichur*

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ABSTRACT. The rainfall data for 59 years (1917-1975) of Raichur was analysed to study the wet spells monthwise by applying logarithmic series to find the distribution pattern of rainfall. The frequency of wet spells were estimated for each month from April to December which are in close agreement with observed frequencies. The probabilities of persistence of rainfall on the $(r+1)$st day, if the rain had occurred on the preceding r days were also calculated.

1. Introduction

The climate of Raichur is semi-arid (Met. monograph, Agrimet/4/1972). The agricultural production of Raichur depends mainly on rainfall. The average rainfall of this place for the period (1917-1975) is 664·3 mm, the maximum rainfall was 1329·4 mm in 1975 and the minimum 304·3 mm in 1941. Because of the large variations annually and also among the months, a fuller understanding of the distribution of rainfall is essential for successful crop production. The probabilities of getting various amounts of rainfall during standard fortnights were estimated by Thimmarayappa and Krishnaiah Setty (1976), but it is necessary to know the distribution of rainy days and the persistence of rainy days during different months which would be helpful in agricultural operations. The monsoon in this region is not made up of a long continuous period of rainy days but it occurs in spells lasting for a few days interspersed by longer dry spells.

Based on a statistical observation of persistence, *i.e.*, "The longer a spell of a particular type of weather, the more likely it is to last another day", Williams (1952) suggested a logarithmic model for study of the wet and dry spells. This approach was followed by Ramabhadran (1954) to study the wet spells of Pune, and then by Srinivasan (1964) to study the rainfall persistence of Raichur and a few other important stations seasonwise. Later, it was also applied by Ramana Rao *et al.* (1974) to study the wet spells of Hebbal region monthwise.

In the present investigation the same technique has been followed to study the wet spells and persistence of rainy days in Raichur, monthwise.

2. Material and methods

The daily rainfall data of Raichur for a period of 59 years (1917 to 1975) for the months April to December were collected from the Regional Research Station, Raichur. A rainy day is a day (0830 to 0830 IST next day), on which one cent (0·3 mm) or more of rainfall is received. While finding the lengths of wet spells, it is assumed that the wet spell ends exactly at the end of the month and another spell starts at the beginning of the next month, in case of a spell extending from one month to the next.

The total number of rainy days during 1917-1975, the average number of rainy days, the quartiles, the number of wet spells, the average number of wet spells, the maximum length of wet and dry spells etc for each month from April to December are given in Table 1.

The observed and the estimated frequencies of wet spells of different lengths are given in Table 2. The estimated frequencies were calculated using logarithmic series as in Srinivasan's paper (1964).

If $s_1, s_2, .., s_n$ are the frequencies of the wet spells of lengths 1, 2,.., n days respectively, the frequency of a wet spell of r days s_r given by $s_r = ax^r/r$ where a and x are constants $(0 < x < 1)$

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TABLE 1

Distribution pattern of rainy days (1917-1975)

Item No.	Total, averages and extremes	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
I(a)	Total No. of rainy days of one cent or more	141	237	552	764	714	681	407	132	41
(b)	Averge No. of rainy days	2·4	4·0	9·4	13·0	12·1	11·5	6·9	2·2	0·7
(c)	Quartiles—(*i*) Q_1	1	2	7	9	8	8	4	0	0
	(*ii*) Q_3	3	5	11	17	17	14	9	3	1
II(a)	Total No. of wet spells of different durations	120	188	328	332	325	311	204	85	21
(b)	Average length of wet spell in days	1·18	1·26	1·68	2·3	2·2	2.19	2·0	1·55	1·95
III(a)	Maximum length of wet spell in days	5	5	8	12	16	12	9	5	6
(b)	Maximum length of dry spell in days	30	31	21	18	20	22	31	30	31
IV	Probability of getting a rainy day	0·08	0·13	0·32	0·42	0·39	0·38	0·23	0.07	0·02
V (a)	Total No. of rainy days of 10 cents or more	93	178	406	557	511	512	317	91	27
(b)	Average No. of rainy days	1·6	3·0	6·9	9·4	8·7	8·7	5·4	1·5	0·5
VI	Monthly average rainfall (mm)	13·9	33·7	89·2	121·8	118·2	155·1	95·3	21·9	4·8

which are determined by the following equations :

$$S = \sum_{r=1}^{\infty} s_r = -a \log_e (1-x) \qquad (1)$$

$$T = \sum_{r=1}^{\infty} r s_r = a x/(1-x) \qquad (2)$$

where,

S = Total of frequencies of wet spells and

T = Total number of rainy days.

The persistence probabilities were calculated using the value of x for different months by the following equation given by Srinivasan (1964):

$$P_{r+1} = S_{r+1}/S_r$$

where, P_{r+1} = The persistence probability of rain on at least $(r+1)$ days, if it had rained on the preceding r days.

$S_r = \sum_{m=r}^{\infty} s_m$ = Total number of wet spells of at least r days duration.

$S_{r+1} = \sum_{m=r+1}^{\infty} s_m$ = Total number of wet spells of at least $(r+1)$ days duration.

The persistence probability of rain for different months and for different spell lengths r are given in Table 3. Also, a nomograph representing the relation between the parameter x and persistence probability (percentage) of rain is given in Fig. 1.

3. Results and discussion

The average number of rainy days of one cent or more is maximum in July (13). The total number of wet spells observed is maximum in July (332) giving an average duration of a wet spell as 2·3 days and minimum in December (21). The maximum lengths of wet spells observed is 16 days in August. The maximum lengths of dry spells for different months show that April, May, October, November and December have been completely dry in some year(s) but there has been at least one rainy day in each of the years 1917 to 1975 during June to September. The probability of getting a rainy day is also maximum in July (42 per cent), closely followed by August (39 per cent) and September (38 per cent).

Using χ^2-test it is observed that the difference between calculated and observed frequencies of wet spells is not significant except in July for which χ^2-value is significant at 5 and 2 per cent levels. This is due to large discrepancy between observed and calculated values for one day spell in July which contributes nearly half to the total χ^2-value. The χ^2-values are given in Table 2. From Table 2, it is seen that the values of x, which is called as 'index of persistency' by Ramabhadran, are almost same for July, August and September which suggests that the persistence probability of rain is almost the same

TABLE 2

The observed and the calculated frequencies of wet spells (1917-1975)

Length of wet spell in days		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Obs	107	156	198	153	176	161	104	50	12
	Cal	93·88	146·19	231·32	202·9	175·64	180·85	136·68	67·76	13·87
2	Obs	10	21	74	81	62	67	51	26	4
	Cal	14·58	27·78	67·08	74·06	66·07	66·01	45·79	16·60	4·58
3	Obs	—	6	33	37	36	31	20	7	1
	Cal	3·58	7·04	25·94	36·04	33·82	32·13	20·45	5·46	2·01
4	Obs	1	4	15	24	21	20	16	1	43
	Cal	0·92	2·01	11·26	19·73	19·28	17·59	10·28	2·01	0·99
5	Obs	2	1	4	12	6	10	7	1	—
	Cal	0·25	0·61	5·24	11·52	11·72	10·27	5·51	0·71	0·53
6	Obs	—	—	2	8	8	11	2	—	1
	Cal	—	—	2·53	7·01	7·42	6·25	3·08	—	0·28
7	Obs	—	—	1	8	6	3	3	—	—
	Cal	—	—	1·26	4·39	4·84	3·91	1·77	—	—
8	Obs	—	—	1	6	4	1	—	—	—
	Cal	—	—	0·64	2·80	3·22	2·49	1·04	—	—
9	Obs	–	–	–	2	1	4	1	–	—
	Cal	–	–	–	1·82	2·17	2·62	0·62	—	—
10	Obs	–	–	—	—	1	2	—	—	—
	Cal	–	–	–	1·19	1·49	1·06	—	—	—
>10	Obs	—	—	—	1	4	1	—	—	—
	Cal	—	—	—	0·53	1.71	0·47	—	—	—
Total	Obs	120	188	328	332	325	311	204	85	21
	Cal	113·21	183·63	345·27	361·99	328·05	322·65	225·22	92·54	22·26
a		276·13	384·72	398·83	277·95	231·10	247·74	204·00	139·29	21·01
x		0·34	0·38	0·58	0·73	0·76	0·73	0·67	0·49	0·66
χ^2		7·67	4·69	9·99	22·29*	7·79	12·21	14·50	11·04*	3·62

*Significant at 5 per cent level

TABLE 3

Persistence probability of rain on $(r+1)$st day expressed as percentage* for different months

Month	x	Preceding length of spell in days(r)				
		1	2	3	4	5
Jun	0·58	33	41	45	48	49
Jul	0·73	44	54	59	61	63
Aug	0·76	47	57	61	64	66
Sep	0·73	44	54	59	61	63
Oct	0·67	40	48	53	56	58

*Approximated to the nearest integer

during these months. Also the values of x for July to September are greater than those for the other months which further indicate that the persistence of rain is more during these months than in the other months. It is further confirmed by the fact that the observed frequencies of wet spells exceeding 5 days are more in July (25), August (24) and September (22) than in other months. Also the percentage probability of getting atleast the selected levels of rainfall (2·5 cm and more) are greater in July, August and September than in other months as calculated by Thimmarayappa and Krishnaiah Setty (1976).

The persistence probability of rain on any day following a wet spell of certain days duration in different months can be found from Table 3 or from the nomograph given in Fig. 1.

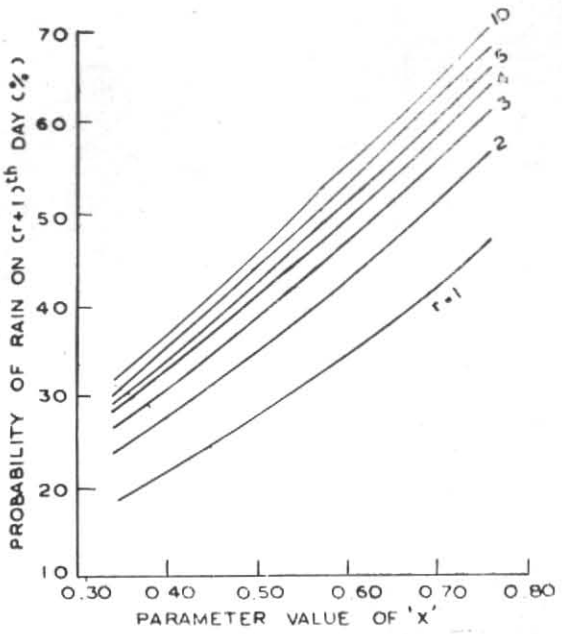

Fig. 1

As the number of wet spells is small in April, May, November and December the persistence probabilities are not given for these months in Table 3 as they may not signify much.

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