

Dry periods during the Southwest Monsoon season in Rajasthan West

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ABSTRACT. Based on data for the period 1901—1950, the incidence of spells of 'no rainfall' in Rajasthan West, during the southwest monsoon season (June to September), has been studied, with week as the unit period of time and district as the unit of area. It has been shown that (i) the number of dry weeks shows a loose negative relationship with total rainfall and the number of rainy days, (ii) there is a pulsating character in the rainfall during the southwest monsoon season, (iii) years with too many or too few rainless weeks are experienced by many districts simultaneously, (iv) prolonged spells of rainless period are common at the commencement and cessation of the season; the second week of August is also a critical period for the setting in of prolonged dry spells. During the period 1901—1950, in the extreme case, in Jaisalmer district in 1918, the whole of the southwest monsoon season was rainless except for 34 mm of rain in the second half of July, (v) Rajasthan West can be divided into three zones, viz., Zone 'A' consisting of Churu, Nagore and Pali districts with least number of dry spells, Zone 'B' consisting of Ganganagar, Jodhpur and Bikaner districts with the number of dry spells increasing and Zone 'C' consisting of Jalore, Barmer and Jaisalmer districts with maximum number of dry spells, (vi) on the basis of the duration of dry spells and their number, an index of "Extreme drought" has been worked out and the districts of southwest Rajasthan has been graded accordingly.

1. Introduction

Rajasthan West with a normal annual rainfall of about 300 mm is the meteorological sub-division of India having the lowest rainfall. It is natural, therefore, that the rainfall of Rajasthan West has received considerable attention from Indian meteorologists. Amongst the more important papers on this subject may be mentioned Pramanik (1952), Pramanik, Hariharan and Ghose (1952) and Rao (1958). However, in all these papers, the problem has been dealt with in terms of the total rainfall during the month, season and/or year. Nevertheless, it is well known that for many purposes, among them agriculture, for considerations of rainfall, even the month is too long a period. Rainfall, week by week, of all the meteorological sub-divisions of India, including Rajasthan West, has been studied by Govindaswamy (1953, 1962), but his studies were confined to the frequencies of only marked abnormalities of the weekly rainfall. Mallik and Godbole (1966) have studied the rainfall of Rajasthan West with the week as the unit period of time and district as the unit of area. They have shown that normally, over quite a large part (western side) of Rajasthan West, even with the district as the area unit, out of the 16 weeks of the southwest monsoon season (June—September), about 8 weeks are entirely dry, i.e., with no rain. These weeks of no rain, during the southwest monsoon season, when about 90 per cent of the total annual amount is received, in an area with very little annual rainfall even normally, obviously aggravates the situation considerably. The different aspects of the occurrence of such dry periods, during the southwest monsoon season, during which period about 90 per cent of the total yearly

rainfall is received, in Rajasthan West, with the week as the unit period of time and district as the unit of area are presented and discussed in this paper.

2. Data used and procedures adopted

Daily rainfall data for the four months of June, July, August and September (the southwest monsoon season) of Rajasthan West were utilised for this study. From the punched cards available, the data were listed separately for periods, each about a week, according to the following schedule.

Week No.	Calendar dates	Week No.	Calendar dates
1	1-8 June	9	1-8 August
2	9-15	10	9-15
3	16-23	11	16-23
4	24-30	12	24-31
5	1-8 July	13	1-8 September
6	9-15	14	9-15
7	16-23	15	16-23
8	24-31	16	24-30

It is realised that the lengths of the period are not strictly uniform. However, this limitation could not be overcome with the punched cards readily available. For the sake of convenience of reference, hereafter, the above periods are referred to as "weeks" even though some of the periods consist of 8 days. The names of the districts and stations as well as the number of years' data utilised are given in Table 1. The total number of weeks data for each of the districts utilised in this paper is 16 × number of years. It will be seen from Table 1 that in the case of Pali and Nagore districts, the

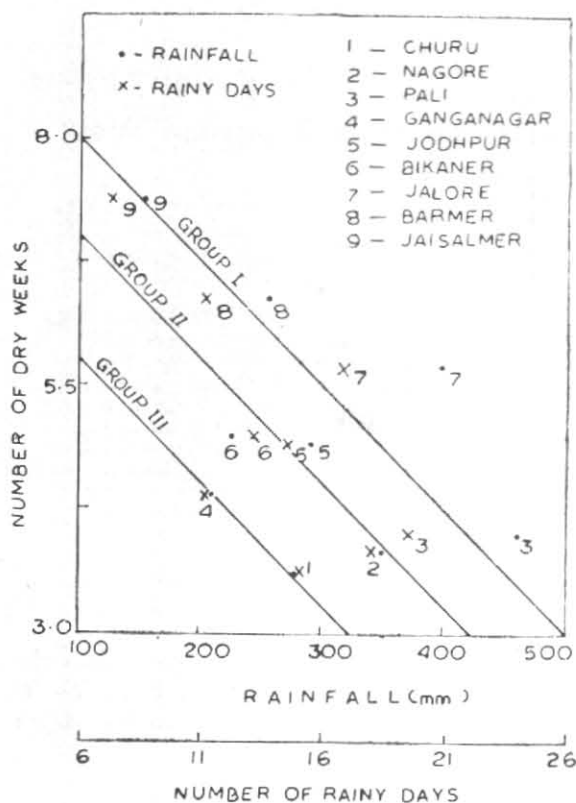


Fig. 1. Dry weeks and rainfall/rainy days

data available are for 50 years for 5 stations and 41 years for one more station. In these cases, the district value represents the average of 6 stations for 41 years and of 5 stations for the remaining 9 years.

Rainfall for each of the above weeks for each individual station was listed and the average rainfall for the district worked out from the station rainfall values. From the week by week district rainfall values, the weeks with no rainfall were picked out, so that a dry week for a particular district means no rain during that week, in any of the stations of the district. In this paper attention is confined to the weeks with no rain, hereafter mentioned as "dry weeks".

3. Variation from season to season

Some aspects of the incidence of dry weeks during the whole of the period covered by the data, are presented in Table 2.

(a) Frequency of occurrence

The districts are arranged according to the normal number of dry weeks per season. It will be seen that out of the 9 districts of Rajasthan West, Jaisalmer at the bottom of the table stands in a class by itself with, normally, about 8 out of the

16 weeks having no rain, showing the least year to year variability in this respect and in the worst year, in 1918, in 14 out of the 16 weeks, there was no rain. At the other end at the top of the table are the districts of Churu, Nagore and Pali (all on the eastern side of the area) with relatively fewer (about 4 out of 16) dry weeks and also with the maximum year to year variability, Churu being the only district with a record of 2 seasons with no dry week. The other districts are in between the above two extremes in these respects.

(b) Relationship between the number of dry weeks and rainfall and rainy days

It may be expected that the normal value of the number of dry weeks (Table 2, col. 2) will show a negative relationship with the normal values of rainfall and the number of rainy days. The normals of number of dry weeks for each of the 9 districts are plotted against the corresponding district normals of total rainfall and number of rainy days for the southwest monsoon season as a whole (June—September) in Fig. 1. It will be seen from Fig. 1 that, considering all the districts together, no relationship is apparent. However, such a negative relationship becomes evident if the whole area is divided into three groups of districts, viz.,

- (1) Pali, Jalore, Barmer and Jaisalmer
- (2) Nagore, Jodhpur and Bikaner, and
- (3) Churu and Ganganagar.

The number of rainy days gives a slightly better fit than rainfall. It is interesting to note that the Pali district fits better into Group 1 according to the rainfall but into Group 2 according to the number of rainy days. This would suggest that the rainfall pattern, *i.e.*, the total rainfall and the number of rainy days, per rainy week, is different in the above three groups of districts.

The other point of interest is the geographical contiguity of the districts in each of the groups and the fact that the three groups lie along an axis approximately parallel to the Aravalli hills.

(c) The best and the worst years

On the basis of the average of the district values, the normal number of dry weeks for Rajasthan West as a whole works out as 5.1 out of the 16 weeks of the season. From this point of view, the best years were 1916 and 1917 (1.9 dry weeks each) and the worst years were 1915 (7.1 dry weeks) and 1918 (9.4 dry weeks). This suggests that it is unlikely that there is any periodicity in the incidence of the dry weeks as a particularly bad year (1915) was followed by two consecutive particularly good years (1916 and 1917) and the next year (1918) was again a

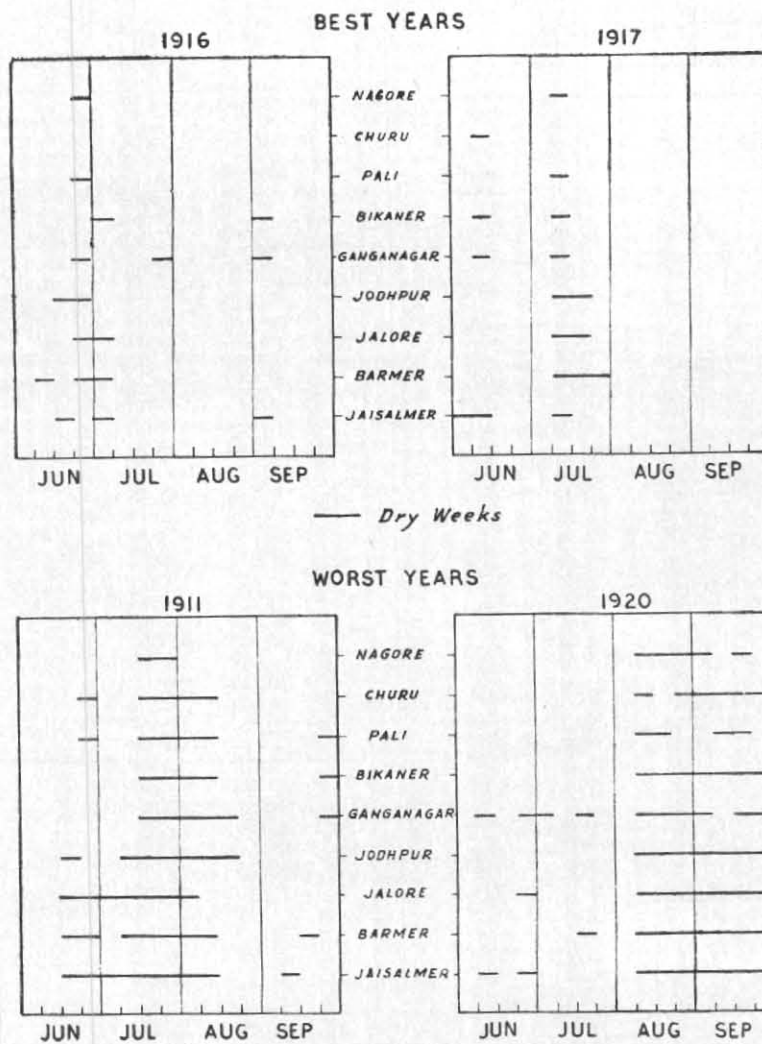


Fig. 2. Highly abnormal years

particularly bad year. The distribution of the dry weeks during the season in each of the 9 districts in the best and the worst years, mentioned above, is shown in Fig. 2.

It is seen from Fig. 2 that (i) in the case of both the best as well as the worst years, the dry weeks in the different districts tend to occur at about the same part of the season. It appears, therefore, that from the point of view of the incidence of dry periods Rajasthan West forms a climatologically homogeneous area, (ii) in 1911, the dry period occurred in the mid monsoon period, i.e., there was a prolonged break in the monsoon. In 1920, the dry period occurred towards the end of the monsoon season, i.e., there was an early withdrawal of the monsoon.

(d) Frequency distribution of seasons with differing number of dry weeks per season

The percentage frequencies of seasons with less than 3 dry weeks, 3 to 5 dry weeks, 6 to 8 dry weeks, 9 to 11 dry weeks and more than 11 dry weeks per season (16 weeks) are presented in Table 3. The arrangement of the districts in this table is in the order of increasing number and duration of dry periods. It will be seen that —

(i) In the case of Churu district, at the top of the table, in 87 (22+65) out of 100 seasons, the dry weeks are less than 6 per season, while even in the worst years (about 13 out of 100) this number does not exceed 8 per season. At the other extreme at the bottom of the table, in the case of Jaisalmer district, there was never a season with less than 3 dry weeks, about 80 (50+30) per cent of the

TABLE 1
Basic rainfall data

Station No.	District and Stations	Number of years' data utilised
JALORE		
1	Jalore	50
2	Sachor	50
3	Jaswantpura	50
PALI		
4	Pali	50
5	Jaitaran	50
6	Desuri	50
7	Bali	50
8	Sojat	50
9	Marwar Junction	41
NAGORE		
10	Nagore	50
11	Didwana	50
12	Parbatsar	50
13	Nawa	50
14	Merta City	50
15	Merta Road	41
CHURU		
16	Churu	45
17	Ratangarh	45
18	Sujangarh	45
19	Sardarshahr	45
20	Rajgarh	45
21	Taranagar	45
22	Dungangarh	45
BARMER		
23	Barmer	50
24	Sheo	50
25	Siwana	50
26	Gudha	49
27	Pachpadra	50
28	Jasol	50
29	Chotan	50
JODHPUR		
30	Jodhpur (Obsy.)	50
31	Bilara	50
32	Phalodi (Obsy.)	50
33	Shergarh	50
BIKANER		
34	Bikaner (Obsy.)	45
35	Lunkaransar	45
36	Palana	45
37	Nokha	45
38	Gajner	45
GANGANAGAR		
39	Anupgarh	45
40	Suratgarh	45
41	Hanumangarh	45
42	Nohar	45
43	Bhadra	45
JAISALMER		
44	Jaisalmer	50
45	Ramgarh	50
46	Devikot	50
47	Dewa	50
48	Bap	50
49	Khaba	50

TABLE 2
Dry weeks from year to year

District	Number of dry weeks out of the 16 weeks of the season		
	Normal	Highest in any year	Lowest in any year
(1)	(2)	(3)	(4)
Churu	3.62 (49)	7	0
Nagore	3.80 (45)	9	1
Pali	4.04 (48)	9	1
Ganganagar	4.40 (34)	10	1
Jodhpur	4.92 (37)	9	2
Bikaner	5.02 (40)	11	2
Jalore	5.72 (48)	12	2
Barmer	6.36 (34)	12	1
Jaisalmer	7.70 (28)	14	3

Note—Figures within brackets represent the coefficient of variability of the normal

TABLE 3

Seasons with differing number of dry weeks in the season

District	Percentage frequency of southwest monsoon seasons with number of dry weeks (out of the 16 weeks of the season) being				
	<3	3 to 5	6 to 8	9 to 11	>11
(1)	(2)	(3)	(4)	(5)	(6)
Churu	22	65	13	0	0
Nagore	28	56	14	2	0
Pali	20	64	14	2	0
Ganganagar	22	51	22	5	0
Jodhpur	8	58	32	2	0
Bikaner	9	51	38	2	0
Jalore	10	38	44	6	2
Barmer	2	28	56	12	2
Jaisalmer	0	16	50	30	4

seasons had from 6 to 11 dry weeks per season and in the worst years (about 4 out of 100) the number of dry weeks exceed 11 per season. The other districts are in between the above two extremes in this respect, as arranged in Table 3 and

(ii) The arrangement of the districts in Table 3, on the basis of the percentage frequencies, is the same as that in Table 2, on the basis of the normal number of dry weeks per season.

4. Variation within the season from week to week

The number of dry weeks expressed as percentage of the total number of weeks, i.e., number of years, separately for each of the 16 weeks of the southwest monsoon season, is given in Table 4. The lowest values of the number of dry weeks are shown in italics in this table. If the lowest values of dry weeks are taken to represent the peaks of monsoon activities, it will be seen that the monsoon activities reach the peak by the beginning of July in Churu district, the third week of July in Pali, Ganganagar, Jodhpur and Bikaner districts and by the last week of July in Nagore, Jalore, Barmer and Jaisalmer districts. Considering the entire area of Rajasthan West, by the beginning of August, the peak of the monsoon activities is over. The values in Table 4 are plotted along with the week by week normal rainfall for each of the weeks from Mallik and Godbole (1966), in Fig. 3. For convenience of reference, the dry week percentages are plotted decreasing upwards and the rainfall values increasing upward in Fig. 3, the variations in the two parameters being in opposite directions (i.e., more dry weeks will normally mean less rainfall and vice versa).

The broad pattern emerging out of Table 4 and Fig. 3 is that the number of dry weeks goes on decreasing from the beginning of the season (June) till about the mid monsoon period (end of July) and thereafter increases till the end of the season (September). Thus the picture in respect of dry weeks is a mirror image of that for rainfall which increases with the advance of the season to a peak and decreases thereafter.

However, within the framework of the above broad picture, there are variations, i.e., an increase in the otherwise decreasing phase of dry weeks during June and July and a decrease in the otherwise increasing phase of dry weeks during August and September. Some of these variations coincide with corresponding variations in the rainfall amounts, (in the opposite directions), but some do not. The more prominent ones of such variations are enumerated below.

During June and July when the general trend is a progressive decrease in the number of dry weeks, i.e., increase in monsoon activities,

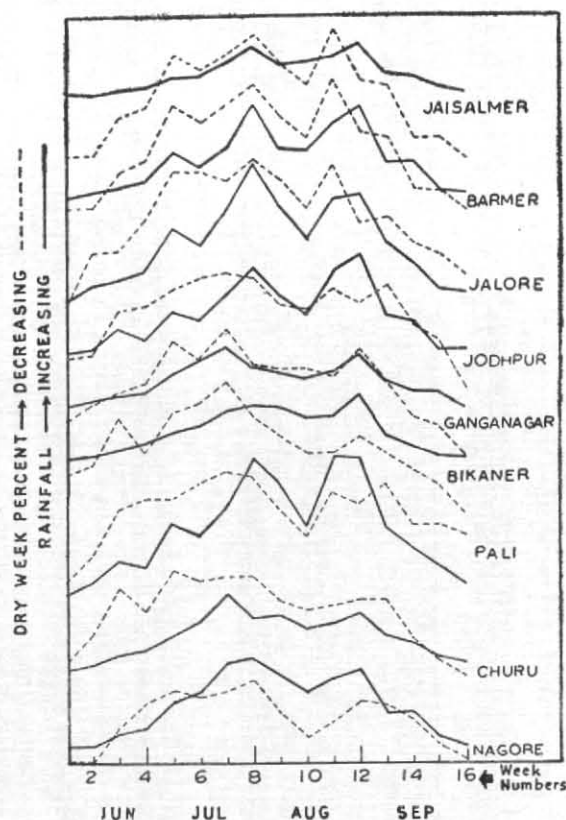


Fig. 3. Rainfall and dry weeks

(a) From about 24 to 30 June, there is an increase in the number of dry weeks in the districts of Churu and Bikaner. A corresponding decrease in rainfall is, however, not noticed for these districts, though it is noticed for Pali and Jodhpur districts.

(b) During the period from about 9 to 15 July there is an increase in the number of dry weeks in 5 out of 9 districts, Pali, Bikaner, Jodhpur and Jalore districts showing a decrease. However, this waning of the monsoon is shown in the case of Pali and Jodhpur districts by decreasing rainfall. In the districts of Jalore and Barmer, the increase in the number of dry weeks coincide with the decrease of the rainfall, both the parameters thus indicating a lull in monsoon activities during 9 to 15 July.

During August and September when the general trend is a progressive increase in the number of dry weeks, i.e., decrease in monsoon activities,

(a) During the period 16 to 23 August (week 11), there is a general resurgence of the rainfall activities as shown by a decrease in the number of dry weeks for all the districts except Ganganagar and

TABLE 4
Variation of dry weeks

District	Number of dry weeks expressed as percentage of total number of weeks in the whole period															
	Week No. of the season															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Churu	42	31	13	22	7	11	9	9	18	22	20	18	18	33	42	47
Nagore	40	40	26	16	12	14	12	8	20	30	24	16	18	24	34	42
Pali	52	42	24	20	20	14	10	12	24	34	18	22	14	30	30	44
Ganganagar	42	35	31	27	11	18	7	20	22	22	25	15	27	40	44	55
Jodhpur	48	46	30	28	22	18	16	18	28	30	22	28	22	36	42	60
Bikaner	42	38	20	33	18	15	7	20	27	33	33	27	33	51	47	58
Jalore	68	48	48	36	20	18	22	14	22	32	16	38	36	46	50	58
Barmer	62	62	48	44	24	30	24	16	28	36	14	34	36	56	56	64
Jaisalmer	64	68	64	64	28	40	20	18	46	46	34	38	46	60	62	72

TABLE 5
Prolonged spells of dry weather

District	Number of spells in the whole period (50 years) lasting for					Duration of the longest spell and the year of occurrence
	3 weeks	4 weeks	5 weeks	6 weeks	>6 weeks	
	(2)	(3)	(4)	(5)	(6)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Churu*	7	4	1	0	0	5 weeks : 1920
Nagore	9	3	0	0	0	4 weeks : 1905, 1907 and 1920
Pali	8	5	0	0	0	4 weeks : 1911, 1937 1939, 1947 and 1949
Ganganagar*	11	4	1	0	0	5 weeks : 1911
Jodhpur	10	4	1	1	1	7 weeks : 1920
Bikaner*	11	9	2	0	1	7 weeks : 1920
Jalore	26	8	2	1	4	8 weeks : 1911
Barmer	21	10	7	2	1	7 weeks : 1920
Jaisalmer	24	16	7	2	4	10 weeks : 1918

*Period is 45 years

Bikaner. In these two districts, the resurgence comes in the next week, *i.e.*, from 24 to 31 August. There is also a general increase in the rainfall amount for the two week period from 16 to 31 August.

The above variations confirm the pulsatory character of the southwest monsoon, mentioned by Gangopadhyaya *et al.* (1963) and Mallik and Godbole (1966), from considerations of the incidence of dry weeks also. Broadly speaking, there appears to be a lull during the fortnight 9 to 15 July and revival during the fortnight 16 to 31 August in the activities of the southwest monsoon over Rajasthan West.

5. Prolonged spells of dry periods

As has been mentioned earlier, in Rajasthan West about 90 per cent of the annual rainfall is received during the southwest monsoon season. Therefore, total absence of rain during this season for the period of one week is bad enough and when dry spells extend over a longer period, *i.e.*, 2 or more weeks, the position becomes serious indeed. An account of the incidence of such dry spells follows.

(a) Frequency of occurrence of dry spells

The numbers of dry spells lasting for 3 weeks or longer during the period of 50 years (1901—1950) experienced in each of the districts are given in Table 5. Duration of the longest dry

spell and the year of occurrence of such spells are also given in this table. It is seen from this table that —

(i) The arrangement of the districts on the basis of prolonged dry spells is the same as in Tables 2, 3 and 4 in which the arrangement of the districts are according to considerations of other aspects. In Churu, Nagore and Pali districts, at the top of the table, dry spells are least prolonged, while in Jaisalmer district, at the bottom of the table, dry spells lasting for more than 6 weeks were experienced in 4 out of the 50 years. The other districts are in between the above two extremes in the order in which they are given in Table 5,

(ii) From the point of view of the longest spell of dry period also, the districts show a similar gradual variation between 4 weeks' spell in Nagore and Pali and 10 weeks' spell in Jaisalmer, and

(iii) The longest spells were experienced in Pali, Ganganagar and Jalore districts in 1911 and in Nagore, Churu, Jodhpur, Bikaner and Barmer districts in 1920.

The best and the worst years considering Rajasthan West as a whole have already been discussed earlier in this paper.

(b) *Commencement in different weeks of the season, of dry spells of 4 weeks or longer*

The question was next examined whether there is any indication that there are critical weeks for the setting in of the dry spells of 4 weeks or longer. The number of such spells commencing in the different weeks of the season as well as the total number of such spells experienced during the whole period covered, for the different districts, are presented in Table 6. As the last week of the season is week No. 16, dry spells of 4 weeks or longer have to commence by week No. 13 at the latest. Hence week Nos. 14, 15 and 16 do not appear in this table. It is seen from this table that —

(i) Considering the total number as given in col. 2 of the table, the frequencies of dry spells of 4 weeks or longer experienced in the different districts are of the order of once in 10 years in Churu, Nagore and Pali, once in 7 years in Ganganagar and Jodhpur, once in 4 years in Bikaner and Jalore, once in 5 years in Barmer and more frequently than once in 2 years in Jaisalmer.

(ii) Such spells can be divided into three categories — at the very commencement of the season, at the absolute end of the season and in the mid-season. The problem of dry spells at the very

commencement and at the absolute end of the season is discussed in the next section.

(iii) Considering the mid-season spells, it is seen that the first three weeks of August, particularly the second week, is a period when there is some risk of dry spells of 4 weeks or longer setting in.

(iv) Once the season starts with some rain during the first week of June, there is little risk of the dry spells setting in thereafter till the end of July, being prolonged beyond 3 weeks. In the Pali district, however, such a spell can commence in the third week of July, once in 25 years.

(c) *Shortening of the rainy period*

The southwest monsoon season consists of 16 weeks. However, often the onset of the monsoon is delayed and/or the withdrawal of the monsoon is earlier, thus reducing the length of the rainy period. The frequency of such shortening of the rainy period for each of the districts is given in Table 7. It will be seen from this table that broadly speaking —

(i) Delayed onset of the monsoon or earlier withdrawal of the monsoon by 1 or 2 weeks is experienced in two out of every 5 years.

(ii) Shortening of the period by more than 2 weeks, by delayed onset of the rainy period, is less frequent than earlier withdrawal except in Jalore district where delayed onset is slightly more frequent than earlier withdrawal.

(iii) Even by late onset and early withdrawal in the same year, the total shortening of rainy period by more than 4 weeks is not common in Nagore, Pali, Ganganagar and Jodhpur districts, but occurs in Churu (once in fourteen years), in Bikaner (once in ten years), in Jalore (twice in ten years), in Barmer (thrice in ten years) and in Jaisalmer (four times in ten years).

(iv) The maximum shortening experienced so far varies from about 4 to 8 weeks except in Jaisalmer.

(v) In Jaisalmer district in the year 1918, during the period of 2 weeks from 16 to 31 July, only some rain (34.3 m) was received, the rest of the southwest monsoon season being absolutely dry.

6. Index of 'Extreme Drought'

Assuming that the adverse effects of the dry spells increase with the duration of the spells and that the effects of a two weeks' spell of dry weather are more than twice the adverse effects of a one week's spell and so on, the following procedure was adopted for obtaining the index of 'Extreme Drought' for each of the districts.

$$E. D. = (n_1 \times 1) + (n_2 \times 2) + (n_3 \times 4) + (n_4 \times 8) + (n_5 \times 16)$$

TABLE 6

Prolonged dry spells — Number of dry spells of 4 weeks or longer

District	Total during the period of 50 years	Dry spells commencing in week number												
		1	2	3	4	5	6	7	8	9	10	11	12	13
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Churu	5	1						1					1	2
Nagore	3	1									1			1
Pali	5	1						2		1	1			
Ganganagar	7	1							1			2		3
Jodhpur	7						1	1		1	2			2
Bikaner	12	2						1		1	3		1	4
Jalore	14	4		1		1				1	2	1	1	3
Barmar	20	6	1			1	1			1	1	1	3	5
Jaisalmer	30	12		2						1	2	3	3	4
Rajasthan West (average of all districts)	11.4	3.1	0	0.3	0	0.2	0.2	0.5	0.2	0.8	1.4	0.8	1.0	2.7

TABLE 7

Shortening of the rainy period

District	Percentage of years when the rainy period (16 weeks) was reduced by dry spells									Maximum reduction in any season and the year of occurrence
	At the beginning of the season causing late commencement of the rains by			At the end of the season causing early cessation of the rains by			At the beginning and end of the season in the same year by			
	1 or 2 weeks	3 or 4 weeks	>4 weeks	1 or 2 weeks	3 or 4 weeks	>4 weeks	1 or 2 weeks	3 or 4 weeks	>4 weeks	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Churu	38	4	0	34	11	2	42	18	7	5 weeks : 1919, 1920 and 1929
Nagore	38	2	0	30	12	0	44	18	4	5 weeks : 1905 and 1908
Pali	48	4	0	36	8	0	44	28	0	4 weeks : 1912; 1918 and 1947
Ganganagar	34	9	0	38	18	0	32	34	4	5 weeks : 1919
Jodhpur	44	4	0	46	12	2	54	28	2	7 weeks : 1920
Bikaner	38	4	0	32	22	4	40	24	11	7 weeks : 1920
Jalore	38	30	0	34	18	6	30	38	20	9 weeks : 1923
Barmar	38	16	8	34	24	6	28	24	30	8 weeks : 1939
Jaisalmer	38	18	8	32	30	10	22	36	36	14 weeks : 1918

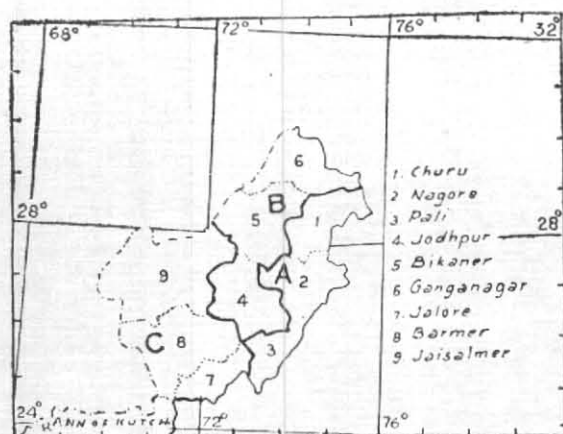


Fig. 4. Zonation by extreme drought

Where E. D. is extreme drought and n_1, n_2, n_3, n_4 and n_5 represent the number of times during the whole period (50 years) when dry spells of 1, 2, 3, 4 and > 4 weeks respectively were experienced. However, as will be seen from Table 1, the period covered in the case of Churu, Ganganagar and Bikaner districts is only 45 years while for the other 6 districts this period is 50 years. Therefore, extreme drought (E.D.) was divided by the number of years of data to obtain the Index of Extreme Drought (I.E.D.), i.e., $I.E.D. = E.D./45$ in the case of Churu, Ganganagar and Bikaner districts and $I.E.D. = E.D./50$ in the case of the other 6 districts. The index of extreme drought thus obtained for each of the districts are given below —

District	Index of Extreme Drought	District	Index of Extreme Drought
Nagore	4.4	Bikaner	7.4
Churu	4.5	Jalore	8.1
Pali	4.6	Barmer	9.7
Ganganagar	5.4	Jaisalmer	12.2
Jodhpur	6.4		

It is interesting to note that the values of the indices of extreme drought for the different districts are in good agreement with the arrangement of the districts in Tables 2 to 7 based on considerations of other different aspects of dry periods, even though the procedure adopted for computing the index of extreme drought is entirely empirical.

It would appear that, on the basis of the different aspects of dry periods presented and discussed in this paper, Rajasthan West can be divided into 3 zones. In the increasing order of magnitude of

aridity, these zones are —

- Zone A — consisting of Churu, Nagore and Pali districts with little difference between the three districts,
- Zone B — consisting of Ganganagar, Jodhpur and Bikaner districts with aridity increasing from Ganganagar to Bikaner and
- Zone C — consisting of Jalore, Barmer and Jaisalmer districts with aridity increasing rapidly from Jalore to Jaisalmer, so that Jaisalmer district approaches very nearly the desert conditions.

Such a zonation of the nine districts of Rajasthan West is shown in Fig.4.

7. Conclusions

An attempt has been made to present the picture of the incidence of dry periods during the southwest monsoon season, in Rajasthan West, in terms of the week as the unit period of time and the district as the unit of area. The following broad conclusions have been arrived at —

- (i) There are indications of a negative relationship, though a loose one, between the districtwise normal values of the number of dry weeks on the one hand and the total rainfall and the number of rainy days on the other, for the southwest monsoon season as a whole.
- (ii) The pulsating character of the southwest monsoon is seen in the incidence of dry weeks also.
- (iii) The worst and the best (too many or too few dry weeks) years tend to be experienced simultaneously by many districts lending support to the idea that Rajasthan West is a homogeneous climatic area.

(iv) Dry spells of 4 weeks or longer are common at the very commencement of the season and at the absolute end of the season caused by the late onset and early withdrawal of the monsoon respectively. The second week of August is also a critical period for the setting in of such dry spells.

During the period 1901 to 1950, the worst season was 1918, in the Jaisalmer district, when but for a rainfall of about 34 mm in the second half of July, the whole of the southwest monsoon season (June to September) was absolutely dry.

(v) From considerations of (a) average number of dry weeks per season, (b) frequency distribution of dry weeks (c) duration of dry spells and (d) shortening of the rainy period by the incidence of dry spells, the 9 districts of Rajasthan West can be grouped into three zones. These are Zone A consisting of Churu, Nagore and Pali districts where the position is least acute, Zone C consisting of

Jalore, Barmer and Jaisalmer districts where the position is most acute and Zone B consisting of Ganganagar, Jodhpur and Bikaner districts where the position is intermediate between those in Zones A and C. Such a zonation is shown in a figure.

(vi) In terms of the number of dry spells and their duration and giving weightage to the prolongation of the spells, an index of 'Extreme Drought' has been obtained for each of the districts. Although the procedure adopted is strictly empirical,

the districtwise values of the index show a good agreement with the conclusions regarding the district to district variation in the incidence of dry periods, arrived at from other considerations.

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