

RAINFALL ANALYSIS FOR RAINWATER MANAGEMENT IN A DROUGHT PRONE AREA

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ABSTRACT

The probability analysis of 31 years (1958-88) rainfall at Bikaner indicated that maximum two days rainfall of 1.01 to 5 years return period vary from 16 to 82 mm with 2 to 24 days as the corresponding length of dry spell and these could be taken as the design storms for rainwater harvesting projects. For planning of the soil and water conservation measure maximum 4 days rainfall of 10 years return period (108 mm) can be taken as the design storm. Probability of growing pasture in this area is 99%, whereas for rainfed crop growing it is only 40% and that too by the middle of July only.

INTRODUCTION

Arid Zones are characterized with sparse and variable precipitation, extreme variation of diurnal and annual temperature and high evaporation. Though in the Bikaner district (20.2°-29.1° N, 71.9°-76.2° E) the mean annual rainfall varies from 300 mm in the east to 180 mm in the west; the year to year variability is high with coefficient of variability ranging from 50 to 65% (Anonymous 1974). Deficit rainfall years account for 2 rainfall years in every 5 years period (Krishanan 1977).

In view of the skewness in the distribution pattern of rainfall, a knowledge of the probability of occurrence of various amounts of rainfall at various time in the rainy season, based on the data collected over a large number of years becomes extremely important. For planning the rainfed crop growing, pasture utilisation, soil and water conservation measures and drinking water supplies such an attempt has been made in the present study.

MATERIAL AND METHODS

In the present study the frequency analysis of 31 years (1958-88) of daily rainfall data has been attempted on annual time series (annual maximum values) through Log pearson type III distribution. Jones (1981) found that this distribution fitted the best to the rainfall probability analysis in the arid regions of the world. The return period values were obtained by Weibulls' formula. The same procedure was also applied to determine the magnitude of rainfall of different return periods for two, three, four and five days. The maximum length of dry spells of different return periods during the monsoon season were also computed following this procedure.

To study the rainfall distribution characteristics during the monsoon season for the Bikaner region, the weekly rainfall data from 27th to 39th standard week (July-September) each year were computed and ranked in the descending order. The probability of occurrence of different amount of rainfall in the specific weeks was derived through the Weibulls' formula. The probabilities for 25, 50, 100 and 150 mm were determined for each of the period through, the Log pearson types III distribution. Similarly, the probabilities of occurrence of different amount of rainfall by different dates during July-September were also computed.

RESULTS AND DISCUSSION

The magnitudes of one to five days maximum rainfall and the length of dry spell obtained by the frequency analysis are presented in Table 1. This indicated that in the range of 20-99% probability (5-1.01 years return period), which is important for drinking water supply, maximum 2 days rainfall (16-82 mm) is the design storm with corresponding length of dry spell varying between 2 and 24 days. For soil and conservation measures and permanent structures rainfall occurring once in 10 to 100 years return period is important (Anonymous 1975). Maximum 4 days rainfall of 108 - 292 mm with corresponding dry spell of 36-93 days is the design storm for such purposes.

Table 1. Maximum storm rainfall (mm) and dry spells of different return periods

	Return period (year)						
	1.01	2.5	5	10	25	50	100
Max. 1—day rainfall	12	46	61	78	98	116	133
Max. 2—days rainfall	16	60	82	103	130	152	175
Max. 3—days rainfall	15	52	82	104	134	158	182
Max. 4—days rainfall	10	49	82	108	180	230	292
Max. 5—days rainfall	5	31	55	84	150	180	235
Max. dry spell in mansoon season (days)	2	14	24	36	55	71	92

The rainfall values of winter and summer rains (Table 2) and annual (Fig. 1) for different return periods show that in the range of 5-10 years return period, which is important for the agricultural purposes, the winter rains (22-39 mm) can meet the demand of rabi crops partially. Further, the summer rains of 200 mm once in 2.5 years of return period is sufficient for the kharif crops and the water supply projects implying adequate rainwater harvesting techniques. 45 mm of summer rain at 99% probability suggests, that the rainfed cropping may not be possible in the region every year. However, 80 mm annual rainfall may be sufficient for the grasslands in the region, and which may occur every year (Return period 1.01 year). Further, the excess rainfall of 467 to 642 mm with 25 to 100 year return periods, may necessitates the adequate protective design of the permanent structures.

Table 2. Seasonal storm rainfall (mm) for different return periods

Season	Return period (year)						
	1.01	2.5	5	10	25	50	100
Winter rain (Jan. & Feb.)	0	6	22	39	56	71	86
Summer rain (July-Sept.)	45	200	278	360	467	553	642
Annual	80	281	395	490	620	720	825

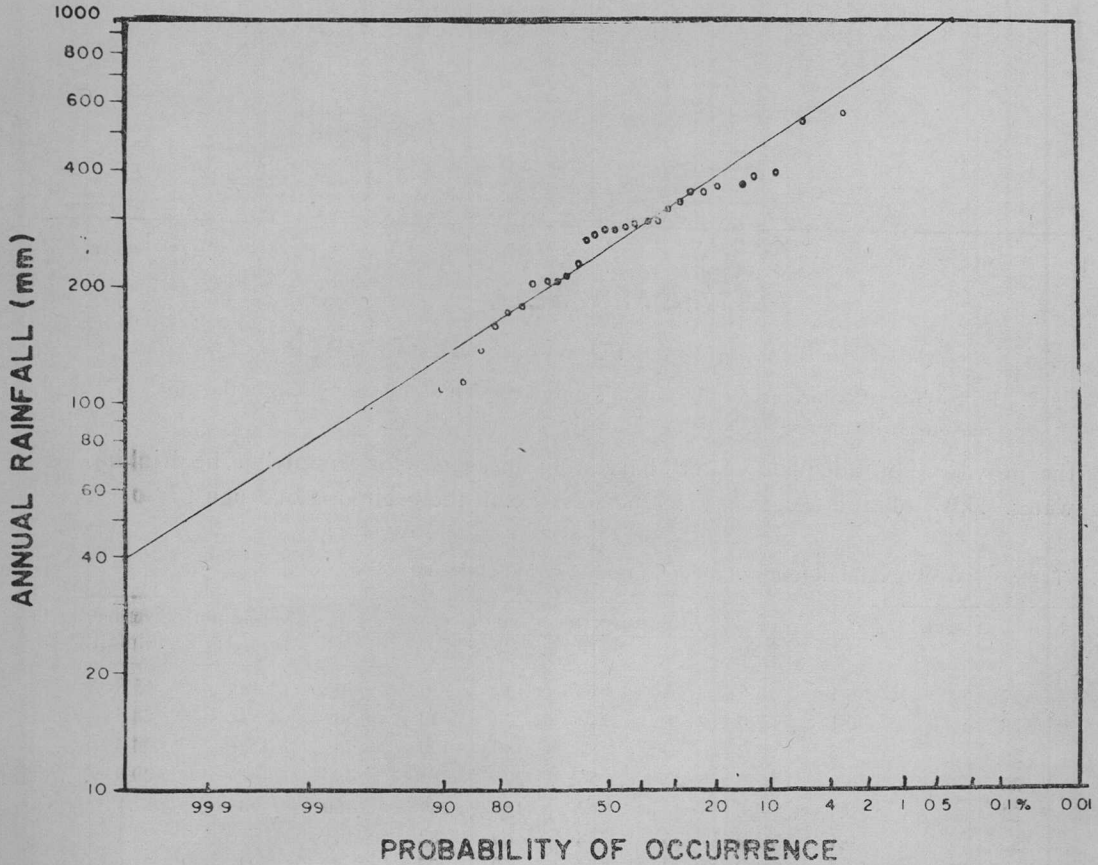


Fig. 1. Probability distribution of the annual rainfall at Bikaner

In order to evaluate the risks of deficit rainfall on crop management and water supply projects, the probability of occurrence of different amounts of rainfall in any week and weekly rainfall of different return periods are depicted in Fig. 2 and Table 3, respectively. The analysis indicates that at 40% probability, the occurrence of dependable rain (> 25 mm) in any week during July-September is limited only to 29th standard week i.e. in the middle of July. Such a situation calls for greater emphasis not only on the conservation of rainfall for crop production but also on

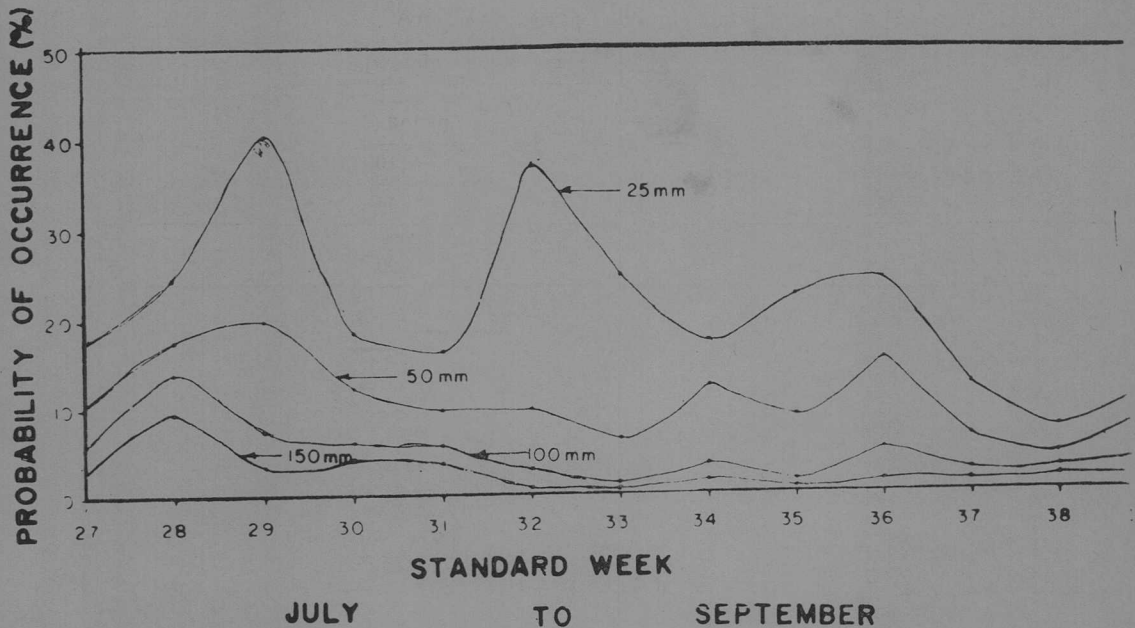


Fig. 2. Probability of occurrence of different amount of rainfall of different weeks in the rainy seasons at Bikaner.

the provision of adequate water harvesting measures for supplying the drinking water. This situation occurs in the 32nd week i.e. at the beginning of August also.

Table 3. Weekly rainfall (mm) of different return period (1958-88)

Standard week	Return period (year)							Maximum rainfall	Average rainfall
	1.01	2.50	5	10	25	50	100		
27	0.1	6.5	21	50	127	230	400	55	15.8
28	0.1	7.0	38	140	200	420	509	81	28.5
29	0.3	25.2	49	81	160	190	256	154	34.4
30	0.1	7.0	23	56	200	284	480	132	29.9
31	0.1	4.8	18	47	184	264	480	58	17.1
32	0.1	23.0	36	48	69	82	101	71	23.1
33	0.1	11.0	34	44	60	72	85	93	21.9
34	0.1	2.3	17	51	89	126	170	86	26.4
35	0.1	2.5	36	45	59	70	81	59	19.2
36	0.1	8.6	33	79	104	127	148	109	35.5
37	0.1	2.8	12	33	65	102	147	101	26.3
38	0.1	0.8	4	15	53	130	286	76	15.3
39	0.1	0.2	3	32	86	112	141	95	30.1

Similarly, the probability of occurrence of 50-100 mm rainfall lies between 10-20% only and that too by the middle of July and the beginning of the September i.e at the onset and withdrawal of the monsoon in the region.

Another important observation out of this analysis is that the rainfed cropping and the harvesting of rainwater may not be possible every year in this region since the probability of occurrence of significant amount of rainfall i.e > 25 mm does not occur every year in any of the week (return period 1.01 year). The rainfall of 4.8 to 25.2 mm does occur with some confidence once in 2.5 year of return period only (Table 3). Significant amount of rainfall i.e. >25 mm is possible once in 5 and more years during every week of the monsoon season.

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