Year to year variations in rainfall totals of Bihar State

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(Received 6 January 1969)

ABSTRACT. The variation of rainfall totals of Bihar Plains and Plateau for sixty years has been examined for *Kharif* and *Rabi* periods using the published monthly rainfall data.

Year to year totals of rainfall of Bihar Plains vary more frequently than that of Bihar Plateau.

Within a period of twelve years Bihar Plains will have less amount of water than required for irrigation purpose and survival of crop. more times than Bihar Plateau.

1. Introduction

It is well known that the success of agriculture depends on sufficient and well-distributed rainfall throughout the growing season. In India, practically the entire rainfall over a major portion of the country is derived from the monsoons, the failure and the delay in monsoons affect the agricultural production. In the absence of rainfall, one has to resort to irrigation, to prevent the crop failure. For irrigation planning it is necessary to find a method of representing the rainfall climate which indicates not only the average value but also the expected variations about the average.

For finding out the frequency and extent of irrigation needed on a given agricultural area, the optimum conditions to be reckoned should be the maintenance of field capacity during the critical periods. The 'average anticipated rainfall' in comparison with the potential evapotranspiration for the area provides a measure of the extent of irrigation to be provided. In regard to productivity, cost of installation and the irrigation potential also can be estimated with these details.

2. Data and scope of study

The purpose here is to study the rainfall climatology of Bihar State divided into (i) the Plains and (i) the Plateau, during the two major cropping season, viz., (a) *Kharif* season — May to October and (b) *Rabi* season — November to April. The study is similar to the one made by Smith (1961) for U. K.

The following six stations were selected to represent the Plains and Plateau portions of Bihar State.

Plains	Plateau
(1) Purnea	(4) Hazaribagh
(2) Patna	(5) Ranchi
(3) Gaya	(6) Naya Dumka

The average annual rainfall of the above stations are given in Table 1. The monthly rainfall data for the years 1901 to 1960 extracted from the records of the India Meteorological Department have been used in the study.

3. Method of analysis

We wish to estimate the total rainfall over a homogeneous area over a specified period of the cropping season in each of the 12 equally probable classes. For this purpose, if X_{ij} is the actual rainfall for the period at the ith station in the jth year then —

$$\overline{X}_i = (1/n) \sum_{j=1}^{n} X_{ij}$$

where n is the total number of years, and

$$r = 100 \; X/\overline{X}.$$

The 'mean quantile levels' for each station are determined such that R_{iq} is the mean of the percentage rainfalls between Q_{q-1} and $Q_q{}^{th}$ quantiles. The areal average $\overline{R}_q$ are determined by utilising all the station values of R_{iq} over the area and thus the mean percentage levels over the area are determined. The mean percentage levels when multiplied by the mean rainfall over the area during the period under consideration, provides the estimate of rainfall in the different quantile classes.

The 'potential evapotranspiration' for the year is calculated as follows. The mean evaporation over the area during the month is picked up

TABLE 1

Annual average rainfall

Plateau	Rainfall (inch)	Plains	Rainfall (inch)
Hazaribagh	51·93	Purnea	58·41
Ranchi	57·59	Patna	43·69
Naya Dumka	59·14	Gaya	43·28
Mean	56·22	Mean	48·46
Mean of six stations : 52·34 inches			

TABLE 2

Percentage of lowest rainfall for *Kharif* period

Period	Plains	Plateau	Mean
May—Jun	23	28	25
Jun—Jul	42	55	49
Jul—Aug	49	62	55
Aug—Sep	49	57	53
Sep—Oct	33	39	36

TABLE 3

Rainfall percentage samples of Bihar Plains and Plateau and their mean

Period		Samples											
		1	2	3	4	5	6	7	8	9	10	11	12
						Kharif Period							
1-month	Plains	22	36	44	54	65	76	88	104	126	149	184	257
	Plateau	26	46	55	63	77	88	98	109	123	143	173	241
	Mean	24	41	49	59	71	82	93	107	125	146	177	249
2-month	Plains	39	54	63	71	78	86	94	103	115	128	143	177
	Plateau	44	62	71	80	86	92	99	107	116	127	143	181
	Mean	41	58	67	75	82	89	97	105	115	127	143	179
3-month	Plains	53	67	74	81	84	93	101	107	115	124	138	165
	Plateau	63	72	79	84	90	96	100	105	116	121	132	153
	Mean	58	69	77	83	87	95	101	106	115	123	135	159
4-month	Plains	57	69	77	82	88	95	101	106	114	122	132	155
	Plateau	69	79	84	89	94	97	103	107	114	122	131	151
	Mean	63	74	81	85	91	96	102	107	114	122	131	153
5-month	Plains	57	71	78	83	89	98	100	106	113	120	131	151
	Plateau	70	79	83	88	91	96	100	105	112	115	124	143
	Mean	63	75	81	85	90	97	100	105	113	117	127	147
6-month	Plains	59	71	78	84	90	95	101	106	111	119	130	150
	Plateau	71	80	84	88	92	96	101	105	111	118	125	141
	Mean	65	75	81	86	91	95	101	105	111	119	127	145
						Rabi Period							
6-month	Plains	23	40	50	60	72	85	96	105	122	149	180	249
	Plateau	19	31	43	55	69	84	100	112	135	152	176	248
	Mean	21	35	47	57	71	85	98	109	129	151	178	249

from the monthly maps of evaporation (Venkataraman and Krishnamurthy 1965). The potential evapotranspiration for the month is obtained from —

$$(PE)_m = E_m d$$

where $d = 0·85$ for the months June through September and $d = 0·60$ for October through May following Ramdas (1957). The total for the period is obtained from the monthly values.

The 'Surplus' or 'Deficit' of rainfall in different quantile classes are determined by subtracting the estimated rainfall in the differnt quantile classes from the potential evapotranspiration for the period.

The periods considered are of length 1,2,3,4,5 and 6 months of the *Kharif* cropping season and length 6 months only of *Rabi* season. The different combinations of the consecutive months

TABLE 4

' Surplus' and 'Deficit' statistics in respect of 2-month periods

Period		Samples 1	2	3	4	5	6	7	8	9	10	11	12
Bihar Plateau													
Annual mean rainfall (R) = 56·22 inches and mean evapotranspiration (E_t) = 49·90 inches													
May–Jun	Percentage	29	50	56	66	75	82	93	104	119	136	164	230
	Rainfall (inch)	16·30	28·11	31·48	37·11	42·17	46·10	52·28	58·47	66·90	76·46	92·20	129·31
	$E_t — R$	33·60	21·79	18·42	12·79	7·73	3·80	−2·38	−8·57	−17·00	−26·56	−42·30	−79·41
Jun–Jul	Percentage	55	67	77	84	89	92	99	106	114	124	137	165
	Rainfall (inch)	30·92	37·67	43·29	47·22	50·03	51·72	55·66	59·59	64·09	69·71	77·02	92·76
	$E_t — R$	18·98	12·23	6·61	2·68	−0·13	−1·82	−5·76	−9·69	−14·19	−19·81	−27·12	−42·86
Jul–Aug	Percentage	62	73	81	86	91	89	99	104	109	118	133	159
	Rainfall (inch)	34·86	41·04	45·54	48·35	51·16	50·03	55·66	58·47	61·28	66·34	74·77	89·39
	$E_t — R$	15·04	8·86	4·36	1·55	−1·26	−0·13	−5·76	−18·57	−11·38	−16·44	−24·87	−39·49
Aug–Sep	Percentage	57	69	77	86	89	98	103	107	113	121	139	164
	Rainfall (inch)	32·05	38·79	43·29	48·35	50·03	55·09	57·91	60·15	63·53	68·03	78·15	92·20
	$E_t — R$	17·85	11·11	6·61	1·55	−0·13	−5·19	−8·01	−10·25	−13·63	−18·13	−28·25	−42·30
Sep–Oct	Percentage	26	65	65	76	86	93	101	112	121	132	114	204
	Rainfall (inch)	14·62	36·54	36·54	42·73	48·35	52·28	56·78	62·97	68·03	74·21	64·09	114·69
	$E_t — R$	35·28	13·36	13·36	7·17	1·55	−2·38	−6·88	−13·07	−8·31	−24·31	−14·19	−64·79
Bihar Plains													
Annual mean rainfall (R) = 48·46 inches and mean evapotranspiration (E_t) = 53·08 inches													
May–Jun	Percentage	23	34	40	46	54	65	75	84	102	123	144	187
	Rainfall (inch)	11·15	16·48	19·38	22·29	26·17	31·50	36·35	40·71	49·43	59·60	69·78	90·62
	$E_t — R$	41·93	36·60	34·70	25·79	26·91	11·58	16·73	12·37	3·65	−6·52	−16·70	−37·54
Jun–Jul	Percentage	42	61	70	78	86	92	97	106	115	128	144	170
	Rainfall (inch)	20·35	29·56	33·92	37·80	41·67	44·58	47·00	51·37	55·73	62·03	69·78	82·38
	$E_t — R$	32·73	23·52	19·16	15·28	11·41	8·50	6·08	1·71	−2·65	−8·95	−16·70	−29·30
Jul–Aug	Percentage	49	65	73	81	87	93	101	108	115	125	137	160
	Rainfall (inch)	23·75	31·50	35·37	39·25	42·16	45·07	48·94	52·34	55·73	60·57	66·39	77·54
	$E_t — R$	29·33	21·58	17·71	13·83	10·92	8·01	4·14	0·74	−2·65	−7·49	−13·31	−24·46
Aug–Sep	Percentage	49	63	71	75	84	90	98	107	117	124	136	174
	Rainfall (inch)	23·75	30·53	34·41	36·35	40·71	43·61	47·49	51·85	56·70	60·09	65·91	84·32
	$E_t — R$	29·33	22·55	18·67	16·73	12·37	9·47	5·59	1·23	−3·62	−7·01	−12·83	−31·24
Sep–Oct	Percentage	33	48	61	71	79	89	98	112	125	140	156	194
	Rainfall (inch)	15·99	23·26	29·56	34·41	38·28	43·13	47·49	54·27	60·57	67·84	75·60	94·01
	$E_t — R$	37·09	29·82	23·52	18·67	14·80	9·95	5·59	−1·19	−7·49	−14·76	−22·52	−60·93

are considered, *e.g.*, for 6-month period — May to October, for 5-month period — May to September, June to October.

4. Results

From Table 1 it is seen that Bihar Plateau received on an average more rainfall than the Plains; this may be one of the reasons for occurrence of frequent droughts in the Plains than the Plateau. The mean lowest rainfall percentages in the Plains and Plateau regions for two months period shown in Table 2 clearly show the relative superiority of the Plateau over the Plains. It can be inferred, therefore, that during all the two month periods of *Kharif* season the Plains are having less amount of water than required

by the field which may be a cause for more droughts than at Plateau. The percentage levels of rainfall for the different periods of the *Kharif* season varying from 1 to 6 months and for whole of the *Rabi* season (6-month only), separately for the Plains and Plateau and for whole of the Bihar are given in Table 3. The mean percentage levels of rainfall during each of the two consecutive months of the *Kharif* season and the surplus and deficit statistics in respect of the 12 quantiles are given in Table 4. It can be observed that the Bihar Plateau and Plains will have less amount of rainfall than required to the field for survival of crop. Table 5 gives comparative drought (deficit of water) conditions in the Plains and Plateau of Bihar State within a period of 12 years.

TABLE 5

Period	No. of years drought condition experienced			
	Bihar Plateau		Bihar Plains	
	(Yr)	(%)	(Yr)	(%)
May–Jun	6	50	9	75
Jun–Jul	4	33·33	8	66·67
Jul–Aug	4	33·33	8	66·67
Aug–Sep	4	33·33	8	66·67
Sep–Oct	5	41·67	7	58·33

5. Conclusions

The above studies indicate that year to year totals of rainfall of Bihar Plains vary more frequently than that of Plateau. Within a period of 12-year Bihar Plains region receives less amount of water than required for irrigational purpose and survival of crop than Plateau.

6. Acknowledgement

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