Drought conditions in the Telengana Division (Andhra Pradesh) during the Southwest Monsoon season

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ABSTRACT. Departure from normals of seasonal rainfall (June to September) of Telengana Division of Andhra Pradesh was studied to assess the frequency and intensity of droughts. But this criteria was found unsatisfactory. Frequency distribution of run of dry spell was, therefore, considered taking a dry day as a day with rain less than 15 cents, since it was felt that the drought conditions are not so much dependant on the total seasonal rainfall as on the length of the dry spell or spells. Probability of dry spell and their average expected number per season was calculated for the various States and it has been submitted that a 25 per cent increase in 10-day dry spell may be deemed to constitute a drought condition.

1. Introduction

Statements were made in 1960 by the public that failure of the southwest monsoon rains in Telengana Division (Andhra Pradesh) had resulted in drought conditions in this area causing hardship to the population. It was also remarked that 1960 might be amongst the worst drought years on record for this area.

In view of the interest from the national point of view, a study of 70 years' rainfall data (1891—1960) of Telengana Division of Andhra Pradesh (consisting of 9 districts, namely, Adilabad, Nizamabad, Karimnagar, Medak, Hyderabad, Mahbubnagar, Nalgonda, Khammamet and Warangal) was undertaken on similar lines as was done for Madras State by Krishna Rao (1953). The rainfall data utilised are the district averages which are the arithmetic averages of the rainfall of various State and observatory raingauge stations in a district, published by the State Rainfall Registration Authority. These were compared with the district normals of 1940 (India met. Dep. 1949).

Rainfall studies for some stations in Hyderabad State has been made by Rao (1959) also; one of the important results of interest to the present study is the inference that decade averages of annual rainfall in most stations do not vary significantly from that obtained for the entire period (1876—1955), lending support to the fact that district normals based on data upto 1940 are not likely to have changed significantly in recent years.*

It was noted from the study of 70 years' rainfall data of Andhra Pradesh during sowing and transplantation season (June to August) that the drought position in various districts in 1960 is absolutely different from that of the seasonal rainfall (June to September). Rainfall deficiency in various districts which was significant during the period June to August could not be detected by the consideration of only seasonal rainfall. It was, therefore, realised that consideration of the seasonal rainfall alone is perhaps not a sufficient criterion for evaluating the drought susceptibility of any region. Prolonged dry

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*Subsequent to the submission of the paper, India Meteorological Department Memoir, Vol. XXXI, part III (1962) containing seasonal district normals based on data 1901—1950 became available. Confirmation of this view was obtained when 1940 and 1950 normals were compared and it was noticed that the value of seasonal district normal differed by less than 5 per cent in most cases.

Fig. 1. Map of Telengana Division

spells during the period of crop development even if these were interspersed with wet spells which made up the subnormal or normal rains are injurious. Study of dry spells was, therefore, thought to be a proper approach towards study of drought susceptibility and this has been made in the present paper.

2. Rainfall in southwest monsoon season

A map of Telengana Division appears at Fig. 1. The normal rainfall for the various districts of Telengana for each of the months June to September of the monsoon season as well as the seasonal and yearly values are given in Table 1. The district of Warangal was bifurcated into two separate districts Warangal and Khammamet after 1956. However, the district Warangal in our study has been taken to comprise of both the present districts of Warangal and Khammamet. The normal seasonal rainfall of the districts varies between 19 inches in district Nalgonda to 35 inches in district Nizamabad. It may also be noticed that the northern districts of Telengana, namely, Adilabad, Nizamabad, Karimnagar and Warangal have normal seasonal rainfall above 30 inches whereas southern districts Nalgonda and Mahbubnagar get about 20 inches of rain during this period. Nearly all the districts

received about 80 per cent of the annual rain during the southwest monsoon season. The rainiest month is July for the northern districts and September for the southern districts.

3. Rainfall distribution in Telengana Division

The district average rainfall for southwest monsoon season for all the districts for the years 1891 to 1960, as far as available, has been given in Table 2 along with the percentage departure from the normal. The years during which rainfall departure was in defect by more than 11 per cent for the various districts are specially noted and arranged in Table 3 in the descending order of the percentage departure. Table 4 is similar to Table 3 with the difference that rainfall data for three months (June—August) only are considered. It was felt desirable to consider the rainfall defect during this period as existence of drought conditions are more injurious during the sowing of paddy (the most important crop) and it transplantation which is completed in most of the districts by 3rd week of August. Drought conditions of various magnitudes as described in this study are defined below—

	Rainfall deficit from normal lies between
Slight drought	11 to 25 per cent
Moderate drought	26 to 50 per cent
Severe drought	>50 per cent

Table 5 gives the frequency distribution of the number of occasions of drought as defined above in the various districts during the months of June, July, August and September and the season as a whole. Table 6 indicates the percentage departure from normal of seasonal rainfall (June—September) for the Telengana Division as a whole in various years when the drought conditions occurred indicating also the number of districts affected in each of these years. The average seasonal rainfall each year as well as normal rainfall for the Telengana division as a whole was obtained from the average rainfall of the various districts weighted against their areas,

TABLE 1

Normal rainfall* (in inches) of the districts of Telengana Division (Andhra Pradesh)

Districts	June	July	August	September	Seasonal (Jun–Sep)	Annual	Seasonal rain as % of annual
Adilabad	6·99	13·43	8·67	6·37	35·46	42·23	84
Nizamabad	6·93	12·11	9·36	7·17	35·57	42·99	83
Karimnagar	5·73	10·19	7·33	6·79	30·04	38·13	79
Warangal (including Khammamet)	5·80	10·40	7·78	6·92	30·99	39·86	78
Medak	5·76	8·65	6·87	7·11	28·59	35·61	80
Hyderabad	4·07	5·89	5·40	6·40	21·76	29·69	75
Nalgonda	3·96	4·87	4·50	5·70	19·03	27·69	69
Mahbubnagar	3·63	5·65	4·99	6·06	20·33	26·62	76

*Based on data up to 1940

Table 7 gives the same information as in Table 6, but for the period consisting of June to August only.

From a review of the various tables the following facts emerge—

It will be noticed from Table 3 that during the southwest monsoon season severe drought conditions occurred in district Warangal thrice in 70 years, in Adilabad twice in 50 years (between 1911—1960), and in Medak and Nizamabad once each in 69 years and in Karimnagar once in 66 years. Nalgonda, Mahbubnagar and Hyderabad which are the districts comprising the southern half of the Telengana division appear as if they have not been visited by any severe droughts during the years under discussion. A reference to Table 5 which gives the frequency of droughts based on the analysis of Table 3, indicates that considering all the occasions when either moderate or severe drought occurred, Warangal had 15 such occasions in 70 years, Medak 14 occasions in 69 years and Karimnagar 12 in 66 years. In other words, the districts of Warangal and Medak could expect a moderate to severe drought on an average once in 5 years and Karimnagar once in 6 years. The rest of the districts may be visited by a moderate to severe drought on an average once in 8 to 10 years. It is also manifested that of all the districts Mahbubnagar is the least likely to be affected by drought as the incidence of drought in the district is once in 14 years. It may, therefore, be inferred that the northern districts of Telengana are likely to suffer more from droughts than its southern districts. It may also be noticed (Table 5) that the rainfall during the month of June was most variable as the highest incidence of moderate to severe drought were recorded during this month, in almost all the districts.

It will be noticed from Table 3 that in the year 1899 there was a severe drought condition in two districts and near severe drought condition in other two districts and slight or moderate drought in three of the remaining districts; record for district Adilabad being not available. It was, therefore, thought that the rainfall for Adilabad district may be extrapolated from the seasonal rainfall recorded at the two contiguous districts of Nizamabad and Karimnagar by finding the average departure for these two districts and using that as the departure of seasonal rainfall for Adilabad, to arrive at the seasonal rainfall for this district in 1899. After this was obtained, it was noticed (Table 6) that during 1899 Telengana division experienced its worst drought during the southwest

TABLE 2

Southwest Monsoon (June—September) rainfall departure from normal-
Telengana Division (Andhra Pradesh) districtwise

Year	Karimnagar N: (30·04)		Warangal (30·99)		Nalgonda (19·03)		Mahbubnagar (20·33)		Hyderabad (21·76)		Medak (28·59)		Nizamabad (35·57)		Adilabad (35·46)	
	A.R.	Dep. (%)	A.R.	Dep. (%)	A.R.	Dep. (%)	A.R.	Dep. (%)	A.R.	Dep. (%)	A.R.	Dep. (%)	A.R.	Dep. (%)	A.R.	Dep. (%)
1891	15·65	—48	24·59	—21	16·59	—13	20·81	2	14·94	—31						
1892							43·46	114	38·55	77						
1893	45·42	55	44·71	44	27·53	45	31·46	55	37·98	75	46·40	62	41·66	17		
1894	33·15	10	28·97	—7	21·65	14	32·85	62	23·54	8	27·86	—3	47·48	33		
1895	27·70	—8	22·45	—28	24·94	31	24·83	22	26·18	20	38·77	36	29·70	—17		
1896	24·32	—19	18·89	—39	13·15	—31	17·09	—16	19·52	—10	22·31	13	40·69	14		
1897	22·62	—25	31·54	2	21·04	11	23·72	17	18·99	—13	25·82	—10	32·35	—9		
1898	21·72	—28	27·61	—11	28·02	47	27·70	36	24·76	14	31·00	8	29·55	—17		
1899	16·00	—46	14·57	—53	10·01	—47	17·80	—12	16·39	—25	17·98	—37	14·19	—60	16·63*	—53
1900	34·19	14	31·09	0	20·79	9	17·98	—12	24·93	15	25·90	—9	44·33	25		
1901	15·25	—49	19·62	—37	14·85	—22	18·52	—9	17·20	—21	29·14	2	34·44	—3		
1902	23·77	—21	17·13	—45	15·89	—17	19·61	—4	20·55	—6	30·71	7	30·48	—14		
1903	29·88	0	54·57	76	30·48	60	32·79	61	29·08	34	43·47	52	40·26	13		
1904	27·24	—9	20·65	—33	14·98	—21	23·77	17	17·68	—19	22·52	—21	29·81	—16		
1905	30·20	1	20·36	—34	18·98	0	21·25	5	17·63	—19	22·65	—21	33·54	—6		
1906	29·51	—2	33·16	7	22·94	21	37·53	85	25·23	7	28·39	—1	38·86	9		
1907	23·73	—21	33·53	8	16·93	—11	19·10	—6	19·69	—10	26·71	—7	28·18	—21		
1908	42·61	42	51·00	65	35·82	88	32·44	60	36·16	65	44·81	57	50·09	41		
1909	21·94	—27	27·97	—10	23·11	21	28·67	41	24·00	10	22·54	—21	24·95	—30		
1910	31·37	5	32·37	4	23·15	22	27·70	36	21·81	0	24·45	—14	38·98	10		
1911	17·98	—40	19·16	—38	15·42	—19	22·17	9	18·33	—16	20·24	—29	26·22	—26	32·40	—9
1912			20·73	—33	16·73	—12	24·44	20	20·25	—7	22·01	—23	28·29	—20	30·65	—14
1913			24·34	—21	20·75	9	16·59	—18	16·03	—26	14·36	—50	36·13	2	28·97	—18
1914			47·74	54			35·28	74	37·78	74	39·90	40	54·36	53	27·15	—23
1915			27·18	—12	25·25	33	24·89	22	36·16	66	28·95	1	29·59	—17	27·61	—22
1916	27·43	—9	36·95	19	42·58	124	32·42	59	32·96	51	34·30	20	31·74	—11	30·38	—14
1917	35·76	19	42·92	38	26·67	40	36·66	80	23·78	9	41·98	47	51·95	46	34·31	—3
1918	16·42	—45	13·57	—56	17·79	—7	11·20	—45	15·47	—29	20·58	—28	18·77	—47	15·85	—55
1919	28·75	—4	30·69	—1	15·40	—19	18·67	—8	24·85	14	19·86	—31	26·55	—25	20·99	—41
1920	14·51	—51	12·17	—61	21·07	11	14·67	—28	14·92	—31	10·42	—64	23·56	—34	15·87	—55
1921	30·90	3	35·83	16	19·52	3	18·77	—8	23·27	7	25·25	—12	40·53	14	43·71	23
1922	31·82	6	27·20	—12	24·34	28	15·35	—25	16·08	—26	21·18	—26	28·15	—21		
1923	24·02	—20	28·90	—7	14·99	—21	21·46	6	22·19	2	19·16	—33	28·46	—20		
1924	23·44	—22	33·60	8	24·74	30	22·00	9	20·67	—5	20·73	—27	28·71	—19		
1925	35·15	17	41·52	34	12·40	—35	20·61	2	21·04	—3	30·55	7	25·87	—27		

N—District Normal.   *Extrapolated

TABLE 2 *(contd)*

	Karimnagar N : (30·04)		Warangal (30·99)		Nalgonda (19·03)		Mahbubnagar (20·33)		Hyderabad (21·76)		Medak (28·59)		Nizamabad (35·57)		Adilabad (35·46)	
	A.R.	Dep. (%)	A.R.	Dep. (%)	A.R.	Dep. (%)	A.R.	Dep. (%)	A.R.	Dep. (%)	A.R.	Dep. (%)	A.R.	Dep. (%)	A.R.	Dep. (%)
1926	21·01	—30	24·19	—22	13·39	—30	23·19	14	15·43	—29	19·57	—32	28·84	—19	23·79	—33
1927	27·71	— 8	32·99	6	26·52	39	26·34	30	28·07	28	22·01	—23	28·14	—21	35·35	0
1928	31·22	4	32·48	5	29·45	55	26·46	30	22·43	3	22·70	—21	50·71	43	35·15	— 1
1929	27·10	—10	25·17	—19	19·33	2	14·08	—31	18·23	—16	20·62	—28	29·68	—17	30·57	—14
1930	29·47	— 2	25·67	—17	12·84	—33	25·58	26	21·48	— 1	22·44	—21	27·30	—23	27·81	—22
1931	33·47	11	36·67	18	21·10	11	17·11	—16	29·56	36	25·57	—11	39·18	10	39·12	10
1932	31·69	5	27·90	—10	23·60	24	24·26	19	19·10	—12	25·14	—12	30·21	—15	38·17	8
1933	40·53	35	26·45	—15	21·51	13	22·05	8	30·17	39	37·96	33	44·39	25	47·74	35
1934	36·31	21	36·56	18	21·35	12	23·08	13	19·68	—10	26·18	—18	36·98	4	38·15	6
1935	31·64	5	32·78	6	20·00	5	21·64	6	17·77	—18	30·60	7	34·39	— 3	33·64	—5
1936	34·78	16	34·24	10	16·06	—16	15·21	—25	16·34	—25	25·67	—10	38·97	10	39·34	11
1937	27·62	—8	20·83	—33	18·06	— 5	15·51	—24	16·31	—25	23·37	—18	32·21	— 9	31·59	—11
1938	40·00	33	35·07	13	20·32	9	34·64	70	26·40	21	41·07	44	46·17	30	48·32	36
1939	15·61	—48	21·99	—29	17·54	— 8	15·19	—25	15·49	—29	20·72	—28	21·85	—39	23·55	—34
1940	25·27	—16	34·83	12	16·23	—15	23·28	15	17·00	—22	22·19	—22	36·30	2	38·99	10
1941	18·05	—40	17·94	—42	13·22	—31	12·63	—38	15·79	—27	19·84	—31	28·03	—21	26·89	—24
1942	29·17	— 3	31·01	0	20·67	9	15·29	—25	20·55	— 6	25·80	—10	40·10	13	33·77	— 5
1943	30·35	1	29·14	— 6	20·87	10	22·50	11	26·94	24	30·32	6	35·75	1	31·25	—12
1944	24·84	—17	23·28	—25	16·27	—15	19·21	— 6	21·42	— 2	21·48	—25	28·52	—20	33·10	— 7
1945	28·04	— 7	32·97	6	22·16	16	18·67	— 8	27·49	26	33·68	18	36·42	2	39·02	10
1946	30·59	2	27·12	—12	16·49	—13	21·20	4	20·16	— 7	25·55	—11	31·45	—12	30·26	—15
1947	37·53	22	38·02	23	26·19	38	36·58	80	30·91	42	34·36	20	37·48	5	37·57	6
1948	32·19	7	23·30	—25	13·62	—28	22·98	13	21·58	— 1	26·28	— 8	38·09	7	32·48	— 8
1949	28·94	— 4	30·63	— 1	19·93	5	25·32	25	21·38	— 2	29·97	5	39·83	12	42·72	20
1950	26·70	—11	29·46	— 5	22·15	16	25·36	25	33·84	56	29·81	4	27·94	—21	22·49	—37
1951	24·14	—20	32·21	4	19·28	1	21·30	5	21·75	0	27·23	— 5	32·35	— 9	27·80	—22
1952	19·80	—34	20·20	—35	13·42	—29	14·52	—29	16·08	—26	21·78	—24	23·22	—35	24·57	—31
1953	38·07	27	35·31	14	20·12	6	30·22	49	21·64	— 1	34·63	21	47·14	33	49·48	40
1954	29·27	— 1	36·22	17	25·83	36	29·35	44	22·72	4	36·45	27	37·34	5	39·91	13
1955	40·13	34	32·13	4	23·48	23	34·62	70	37·24	71	43·17	51	34·87	— 2	50·41	42
1956	32·66	9	34·15	10	25·23	33	38·31	88	26·52	22	42·76	50	50·81	43	38·80	9
1957	29·65	— 1	31·38	1	21·10	11	22·77	12	26·28	21	29·44	3	37·83	6	38·84	10
1958	30·53	2	38·14	23	25·31	33	23·44	15	28·43	31	36·67	28	42·05	18	41·94	18
1959	39·04	30	52·05	68	25·58	34	25·14	23	32·38	49	38·71	35	56·57	59	43·42	22
1960	25·79	—14	31·45	1	23·76	25	17·56	—14	23·32	7	20·65	—28	33·16	— 7	26·76	—25

N—District Normal.

TABLE 3
Seasonal rainfall departure (June—September)—Telengana Division

Karimnagar		Warangal		Nalgonda		Mahbubnagar		Hyderabad		Medak		Nizamabad		Adilabad	
Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)
1920	−51	1920	−61	1899	−47	1918	−45	1891	−31	1920	−64	1899	−60	1920	−55
1901	−49	1918	−56	1925	−35	1941	−38	1920	−31	1913	−50	1918	−47	1918	−55
1891	−48	1899	−53	1930	−33	1929	−31	1918	−29	1899	−37	1939	−39	1899	−53*
1939	−48	1902	−45	1896	−31	1952	−29	1926	−29	1960	−36	1952	−35	1919	−41
1899	−46	1941	−42	1941	−31	1920	−28	1939	−29	1923	−33	1920	−34	1950	−37
1918	−45	1896	−39	1926	−30	1922	−25	1941	−27	1926	−32	1909	−30	1939	−34
1911	−40	1911	−38	1952	−29	1936	−25	1913	−26	1919	−31	1925	−27	1926	−33
1941	−40	1901	−37	1948	−28	1939	−25	1922	−26	1941	−31	1911	−26	1952	−31
1952	−34	1952	−35			1942	−25	1952	−26	1911	−29	1919	−25	1960	−25
1926	−30	1905	−34					1899	−25	1960	−28				
1898	−28	1904	−33					1936	−25	1918	−28				
1909	−27	1912	−33					1937	−25	1929	−28				
1897	−25	1937	−33							1939	−28				
		1939	−29							1924	−27				
		1895	−28							1922	−26				
		1944	−25							1944	−25				
		1948	−25												
1924	−22	1926	−22	1901	−22	1937	−24	1940	−22	1952	−24	1927	−23	1941	−24
1920	−21	1891	−21	1904	−21	1930	−18	1901	−21	1912	−23	1930	−23	1914	−23
1907	−21	1930	−21	1922	−21	1896	−16	1904	−19	1927	−23	1907	−21	1915	−22
1923	−20	1929	−19	1911	−19	1931	−16	1905	−19	1930	−22	1922	−21	1930	−22
1951	−20	1956	−18	1919	−19	1960	−14	1935	−18	1940	−22	1941	−21	1951	−22
1896	−19	1930	−17	1902	−17	1899	−12	1911	−16	1904	−21	1950	−21	1913	−18
1944	−17	1915	−12	1936	−16	1900	−12	1897	−13	1905	−21	1912	−20	1946	−15
1940	−16	1922	−12	1940	−15			1932	−12	1909	−21	1923	−20	1912	−14
1960	−14	1946	−12	1944	−15					1928	−21	1944	−20	1916	−14
1950	−11	1898	−11	1891	−13					1937	−18	1924	−19	1929	−14
				1946	−13					1910	−14	1926	−19	1943	−12
				1912	−12					1921	−12	1895	−17	1937	−11
				1907	−11					1932	−12	1898	−17		
										1931	−11	1915	−17		
										1946	−11	1924	−17		
												1904	−16		
												1932	−15		
												1902	−14		
												1946	−12		
												1916	−11		

*Computed by extrapolation

TABLE 4

Percentage rainfall departures (June—August) from normals—Telengana Division

Karim-nagar		Warangal		Nalgonda		Mahbub-nagar		Hyderabad		Medak		Nizamabad		Adilabad	
Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)
1920	—52	1920	—57	1899	—41	1918	—70	1918	—42	1920	—65	1899	—53	1920	—61
1891	—48	1902	—54	1918	—40	1899	—49	1926	—41	1913	—55	1929	—44	1918	—55
1923	—47	1941	—54	1940	—37	1941	—46	1902	—37	1929	—52	1924	—42	1899	—55*
1899	—46	1918	—50	1948	—37	1931	—44	1922	—36	1923	—47	1918	—41	1919	—42
1939	—45	1899	—49	1926	—35	1929	—41	1891	—35	1950	—44	1950	—40	1941	—41
1941	—45	1923	—48	1952	—34	1960	—34	1937	—34	1924	—43	1922	—38	1950	—41
1924	—45	1895	—39	1930	—31	1922	—31	1920	—33	1899	—41	1923	—38	1952	—40
1918	—42	1911	—36	1925	—30	1920	—30	1929	—33	1918	—39	1930	—38	1929	—38
1952	—40	1952	—35			1937	—29	1904	—29	1944	—39	1939	—35	1939	—38
1897	—39	1905	—35			1952	—28	1941	—29	1908	—34	1952	—34	1930	—33
1901	—37	1904	—34			1939	—27			1941	—34	1944	—33	1915	—32
1911	—33	1896	—32			1943	—27			1910	—34	1909	—32	1911	—31
1960	—32	1947	—31							1894	—34	1905	—31	1945	—28
1895	—29	1912	—30							1904	—33	1920	—30	1914	—28
1950	—29	1937	—30							1922	—33	1941	—30	1916	—25
		1948	—30							1928	—31	1919	—29		
		1939	—30							1926	—30	1915	—27		
		1944	—29							1936	—28	1904	—25		
										1939	—26				
										1900	—25				
										1919	—25				
										1927	—25				
1951	—20	1901	—23	1902	—23	1908	—19	1936	—24	1912	—24	1907	—24	1926	—24
1948	—19	1929	—23	1939	—22	1900	—15	1894	—23	1931	—24	1911	—20	1960	—24
1944	—19	1924	—22	1896	—21	1949	—15	1939	—22	1937	—23	1925	—20	1948	—22
1926	—19	1891	—21	1919	—21	1944	—11	1952	—22	1902	—22	1895	—16	1912	—19
1907	—19	1943	—18	1943	—19			1960	—22	1905	—22	1897	—16	1944	—19
1909	—16	1894	—18	1940	—17			1935	—20	1943	—21	1916	—16	1913	—17
1943	—16	1921	—17	1944	—16			1899	—18	1897	—20	1943	—16	1937	—17

*Computed by extrapolation.

TABLE 4 (contd)

Karimnagar		Warangal		Nalgonda		Mahbubnagar		Hyderabad		Medak		Nizamabad		Adilabad	
Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)	Year	Dep. (%)
1929	−15	1930	−17	1950	−15			1932	−18	1948	−20	1960	−16	1951	−17
1904	−14	1898	−16	1911	−12			1944	−17	1945	−19	1910	−14	1917	−12
1908	−14	1932	−16	1936	−11			1913	−16	1911	−17	1927	−14		
1937	−14	1956	−16					1897	−15	1950	−17	1902	−13		
1898	−11	1900	−12					1923	−14	1952	−16	1935	−12		
1902	−11	1913	−12					1953	−14	1909	−13	1947	−12		
1916	−11	1922	−12					1928	−13	1932	−13	1912	−11		
1954	−11	1935	−11					1924	−11	1940	−12	1932	−11		
								1954	−11						

TABLE 5

Frequencies of Droughts

Districts	Data available (No. of years)	June			July			August			September			Season			Moderate to severe drought during the season (No. of years)
		(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	
Karimnagar	66	3	7	15	8	13	12	9	17	7	9	7	14	14	11	1	12
Warangal	69	8	15	12	12	11	11	8	17	7	10	15	8	11	12	3	15
Nalgonda	70	8	16	10	12	11	6	10	7	7	9	14	5	13	8	0	8
Mahbubnagar	70	4	13	9	4	7	6	9	11	10	10	10	7	11	5	0	5
Hyderabad	70	8	15	11	11	12	4	11	16	3	7	15	8	12	9	0	9
Medak	69	8	15	17	11	15	9	9	12	7	12	13	4	16	13	1	14
Adilabad	47	5	11	6	8	7	8	6	11	6	3	10	3	13	5	2	7
Nizamabad	69	13	15	16	15	14	10	11	15	3	7	7	11	21	7	1	8

(a) Slight drought   Slight drought deficiency 11 to 25 per cent

(b) Moderate drought   Moderate drought deficiency 26 to 50 per cent

(c) Severe drought   Severe drought deficiency above 50 per cent

TABLE 6

Percentage departure from normal of seasonal rainfall for Telengana Division in years of drought*

Rank No.	Year	Average rainfall	Normal	Percentage departure	No. of districts affected
I	1899	15·45	27·72	—44	7
II	1920	15·90		—43	7
III	1918	16·21		—42	7
IV	1939	18·99		—31	7
V	1941	19·05		—31	6
VI	1952	19·20		—31	7

*All years of study in which the percentage deficiency of seasonal rainfall for Telengana division was more than 25 per cent

TABLE 7

Percentage departure from normal of rainfall (June—August) for Telengana Division in years of drought*

Rank No.	Year	Total rainfall	Normal	Percentage departure	No. of districts affected
I	1899	11·21	21·16	—47	6
II	1918	11·22		—47	7
III	1920	12·28		—42	7
IV	1941	12·74		—40	8
V	1923	14·44		—32	4
VI	1929	14·42		—32	5
VII	1924	14·95		—29	3
VIII	1904	15·54		—27	4
IX	1960	15·54		—27	3

*All years of study in which the percentage deficiency of June —August rainfall for Telengana division was more than 25 per cent

monsoon season, followed closely by the droughts of 1920 and 1918. In each of these years 7 out of 8 districts were affected by moderate to severe drought.

A review of Tables 3 and 4 will provide answers to the query which give rise to this study. It will be noticed that within the meaning of drought condition adopted earlier, there was no drought in the districts of Warangal, Nalgonda, Hyderabad and Nizamabad; there was slight drought in the districts of Adilabad, Mahbubnagar and Karimnagar and only in Medak there was moderate drought during the season as a whole. If on the other hand the rainfall during sowing and transplantation season (June—August) only is considered the drought position is revealed to be worst. It is noticed (Table 4) that except Warangal and Nalgonda, all the other districts were affected by drought; Karimnagar, Mahbubnagar and Medak being the worst affected districts. This change in the drought position can be explained by the fact that although the monsoon rains were scanty in six districts out of eight till August, the deficit was made up by many spells of rain during September 1960 by which time perhaps the crops had withered due to failure of rains in July/ August period.

Considerable difference in drought positions of various districts of Telengana division in 1960 as manifested from rainfall studies of periods June—September and June—August respectively caused a doubt whether consideration of seasonal rainfall alone is sufficient for assessing drought position of a region. where peasants mainly depend on rains for their water requirement during sowing and transplantation period. To fulfill this requirement, it was therefore thought necessary to have such a measure of drought which take into account the variation of the rainfall during the various periods of season. To meet this end further study as described below was necessary.

4. Run of dry spells

One of the methods could be to consider the departure from normal of daily district average rainfall and indicating it in a manner similar to that suggested by Krishna Rao (1959); but the computation required for this purpose would be huge. While considering another suitable parameter for indicating the variation in rainfall during the stages of the monsoon season, it was felt that continuous runs of dry days were most injurious to crops and may be chosen as a better criterion for assessing drought conditions. The ground water could supply the plants with stored subsoil water for its growth only for a limited period but perhaps a continuous dry spell of 7 to 10 days depending on the type of soil, is the most beyond which the subsoil water storage needs replenishment by way of rains. For this study a day was considered dry if the rainfall was less than 15 cents in 24 hours. Frequency distribution of 1-day, 2-day, 3-day .. dry spells was formed, taking into consideration the rainfall in the various districts for the years 1921—1950 (30 years)*. While obtaining these frequencies, a continuous n-day dry spell was broken up into one n-day, two (n—1)- day, three (n—2) day dry spells. Frequency of 1-day, 2-day, 3-day etc dry spells were found. Sixth degree orthogonal polynomials were fitted to this distribution and the values calculated on the basis of these

polynomials satisfied χ^2 test at 5 per cent level of significance. Probabilities of 1-day, 2-day, 3-day etc dry spells in a season were then calculated taking into account the possible total number of 1-day, 2-day, 3-day etc spells in the 30-year period. Average expected number of dry spells per season were also computed to have an idea of average return periods. These results are given in Table 8.

In Table 8 the average number of dry spells of various durations expected during each season deserves particular attention. It indicates that the southern districts, *i.e.*, Mahbubnagar. Hyderabad and Nalgonda are more liable to dry spells. For example a continuous dry spell of 15 days or more can be expected on an avrage on seven occasions per season in Mahbubnagar (southern-most district) but only two such spells in Adilabad. Similarly a 20-day dry spell may occur twice in a season in the former district compared to one in the latter. Another revealing fact is that it is the southern districts Mahbubnagar, Hyderabad and Nalgonda which can expect in each season a dry spell, running continuously for nearly a month, deserving special irrigation facilities in comparison to other districts. Of these, it may be noticed, the southern-most district Mahbubnagar can expect the longest dry spell in each season. If probability of 1-day dry spell is considered, it will be observed that most districts can expect on an average more than 60 per cent days as dry days during the southwest monsoon season.

5. Drought days

The amount of seasonal rainfall was not found to be a sufficiently convincing proof of drought conditions. The occurrence of continuous dry spells of more than the average figures given in Table 8 may offer a correct criterion for assessing drought conditions Since it is felt that a continuous dry spell of 10-days or more is injurious to crop development, a 20—25 per cent increase in the number of dry spells may indicate moderate drought. Similarly an increase of 50 per cent in the number of 10-day dry spells may

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*Years for which records were available without any break for almost all districts

TABLE 8
Probabilities of dry spells and their average expected numbers in a season
in Telengana Division

Length of dry spell in days	WARANGAL		NALGONDA		MAHBUBNAGAR		HYDERABAD	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
1 or more	0·66681	81·35	0·77025	93·97	0·75289	91·89	0·73707	89·92
2 ″	0·52432	63·95	0·63294	77·20	0·62133	75·75	0·59922	73·08
3 ″	0·41516	50·62	0·52112	63·50	0·51557	62·86	0·48771	59·47
4 ″	0·33400	40·72	0·43004	52·42	0·43020	52·44	0·39753	48·46
5 ″	0·26809	32·67	0·35572	43·35	0·36085	43·98	0·32450	39·55
6 ″	0·21913	26·70	0·29489	35·93	0·30398	37·04	0·26521	32·31
7 ″	0·18106	22·05	0·24488	29·82	0·25685	31·28	0·21689	26·42
8 ″	0·15090	18·37	0·20356	24·77	0·21730	26·46	0·17735	21·60
9 ″	0·12645	15·39	0·16922	20·60	0·18372	22·36	0·14483	17·63
10 ″	0·10609	12·91	0·14051	17·10	0·15492	18·89	0·11797	14·36
11 ″	0·08873	10·80	0·11642	14·16	0·13004	15·82	0·09575	11·65
12 ″	0·07365	8·96	0·09614	11·69	0·10850	13·20	0·07733	9·41
13 ″	0·06041	7·35	0·07908	9·61	0·08988	10·93	0·06215	7·56
14 ″	0·04788	5·93	0·06475	7·87	0·07391	8·98	0·04972	6·04
15 ″	0·03867	4·70	0·05280	6·42	0·06038	7·34	0·04107	4·99
16 ″	0·03004	3·65	0·04294	5·22	0·04912	5·97	0·03170	3·85
17 ″	0·02287	2·78	0·03480	4·24	0·03997	4·86	0·02550	3·68
18 ″	0·01713	2·08	0·02844	3·45	0·03274	3·98	0·02084	2·53
19 ″	0·01272	1·54	0·02333	2·83	0·02716	3·30	0·01742	2·12
20 ″	0·00951	1·15	0·01932	2.68	0·02306	2·80	0·01499	1·82
21 ″	0·00730	0·89	0·01616	1·96	0·02002	2·43	0·01325	1·61
22 ″	0·00582	0·71	0·01363	1·65	0·01775	2·15	0·01191	1·45
23 ″	0·00480	0·58	0·01147	1·39	0·01590	1·93	0·01074	1·30
24 ″	0·00393	0·48	0·00952	1·15	0·01419	1·72	0·00950	1·15
25 ″			0·00762	0·92	0·01235	1·50	0·00808	0·98
26 ″			0·00573	0·69	0·01030	1·25	0·00644	0·78
27 ″			0·00394	0·48	0·00810	0·98	0·00473	0·57
28 ″					0·00609	0·74		
29 ″					0·00493	0·60		
30 ″								

(a) Probability of dry spells   (b) Average expected numbers in a season

TABLE 8 (contd)

Length of dry spell in days	MEDAK		KARIMNAGAR		NIZAMABAD		ADILABAD	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
1 or more	0·68768	83·90	0·67535	82·39	0·64819	79·08	0·62056	74·99
2 ,,	0·54809	66·85	0·53249	64·95	0·51314	62·59	0·47125	56·93
3 ,,	0·43870	53·49	0·42214	51·47	0·40852	49·81	0·36415	43·98
4 ,,	0·35287	43·01	0·33691	41·07	0·32748	39·92	0·28637	34·57
5 ,,	0·28520	34·76	0·27083	33·01	0·26452	32·24	0·22851	27·58
6 ,,	0·23142	28·19	0·21918	26·70	0·21523	26·22	0·18403	22·20
7 ,,	0·18821	22·92	0·17829	21·72	0·17622	21·46	0·14856	17·92
8 ,,	0·15304	18·63	0·14537	17·70	0·14486	17·64	0·11938	14·39
9 ,,	0·12401	15·10	0·11840	14·41	0·11924	14·52	0·09493	11·44
10 ,,	0·09977	12·14	0·09589	11·67	0·09797	11·92	0·07442	8·97
11 ,,	0·07938	9·66	0·07687	9·35	0·08007	9·74	0·05746	6·92
12 ,,	0·06219	7·56	0·06070	7·38	0·06482	7·88	0·04385	5·28
13 ,,	0·04779	5·81	0·04699	5·71	0·05213	6·34	0·03332	4·01
14 ,,	0·03589	4·36	0·03550	4·32	0·04142	5·36	0·02250	3·07
15 ,,	0·02632	3·20	0·02610	3·17	0·03265	3·97	0·01981	2·38
16 ,,	0·01888	2·29	0·01868	2·27	0·02568	3·12	0·01553	1·87
17 ,,	0·01339	1·63	0·01311	1·59	0·02036	2·47	0·01188	1·43
18 ,,	0·00964	1·17	0·00923	1·12	0·01653	2·01	0·00825	0·99
19 ,,	0·00733	0·89	0·00681	0·83	0·01395	1·69	0·00439	0·53
20 ,,	0·00614	0·74	0·00553	0·67	0·01234	1·50		
21 ,,	0·00567	0·69	0·00504	0·61	0·01125	1·36		
22 ,,	0·00554	0·67	0·00493	0·60	0·01066	1·29		
23 ,,	0·00536	0·65	0·00484	0·59	0·00988	1·20		
24 ,,					0·00873	1·06		
25 ,,					0·00704	0·85		
26 ,,					0·00482	0·58		
27 ,,								
28 ,,								
29 ,,								
30 ,,								

(a) Probability of dry spells　　　　(b) Average expected numbers in a season

indicate severe drought conditions. However such criterion may necessarily be fixed after considering the water requirements of the particular crop and the soil of the area under cultivation.

6. Results

The results of the study discussed in the preceding paragraphs can be summarised as follows—

(1) Studies of seasonal rainfall (rain during 1 June —30 September) in Telengana division of Andhra Pradesh indicated that the division had worst droughts in 1899, 1918 and 1920. Other years of droughts of lesser magnitude occurred in 1939, 1941 and 1952.

(2) In 1960 all districts of Telengana division except Warangal and Nalgonda were affected by drought during sowing and transplantation period (June—August); Karimnagar, Mahbubnagar and Medak being the worst affected.

(3) The variation of seasonal rainfall from normal is maximum in the northern districts of Telengana and least in the southern districts. The departure of seasonal rainfall from normal was, however, not found to

be a sufficient measure to assess the drought conditions in an area.

(4) All the districts in Telengana division are expected to face more than 60 per cent dry days during the southwest monsoon season, Nalgonda and Mahbubnagar districts leading with nearly 75 per cent dry days in each season.

(5) In the southern districts of Telengana, viz., Mahbubnagar, Hyderabad and Nalgonda a dry spell running continuously for nearly a month can be expected to occur in each season and can claim special irrigation facilities to overcome drought conditions. Of these, on an average Mahbubnagar is expected to stand the largest continuous dry spell in any season.

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