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THE SPATIAL ANALYSIS OF RAINFALL IN THE DROUGHT PRONE AREA OF CUDDAPAH DISTRICT, ANDHRA PRADESH

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ABSTRACT: In dry farming areas, rainfall is considered to be an important agro-ecological input to determine the farming types as well as its efficiency. This weather element also describes the surface and sub-surface water resources of a region. In view of deterministic influence exerted by rainfall on agriculture especially in dry areas, the present paper attempts to present the various aspects of the rainfall like rainfall distribution, rainfall intensity, rainfall ratio, rainfall variability and rainfall frequency in the drought prone area of Cuddapah district in Andhra Pradesh. The analysis has been made at rain-guage station level for the period of 88 years i.e., from 1901 to 1988.

Rainfall is an important ecological parameter to agriculture. In any region where agriculture is rainfed, rainfall influences the practices, types, systems and productivity of farming. It is also the dominant single weather element used systematically to assess the surface water resources as well as the drought situation of a region in addition to infiltration, runoff and recharge. It acts as an important input parameter for water balance studies. Therefore, a careful analysis of this parameter is important for water resources planning and crop and land use management. The supply through precipitation has been systematically studied by Indian geographers at regional and basin levels by Bhargava et.al [1964], Ramakrishna Prasad and Narayana [1967], and Dikshit [1979]. They have studied this parameter in a systematic way through statistical techniques to understand the spatial distribution of rainfall intensity, and variability and ratio. Sridaram and Ramachandran [1970], Raman Rao and Murali Mohan [1971], Saxena et.al. [1979] and Murali Mohan and Thimme Gowda [1979] have attempted to study the relationship between the rainfall and cropping pattern. Studied on rainfall trends, patterns, reliability, deficiencies and excesses are carried out by Sinha [1959], George [1962], George and Vasudevan [1963], Ananakrishna and Rajagopalachari [1964] Srinivasan [1964], Bedkar and Banerjee [1969] Pardhasaradhi and Dhar [1970], Raghavendra [1974] and Bishnoy [1975].

In the present study an attempt is made to describe the spatial distribution of rainfall, rainfall intensity, rainfall ratio, rainfall variability and rainfall frequency in Cuddapah district on seasonal and annual basis. Rainfall from 1901 to 1988 is taken for nine rain-guage stations and analysed.

STUDY AREA :

The Cuddapah district situated in the South-Central part of Andhra Pradesh State, is one ofthe most backward and drought prone area of this country. Having an area of 15,378.41 sq.km., geographically the district forms the southern and south-eastern portion of the Deccan Plateau in peninsular India. Geomatically, Cuddapah district is located between the latitudes 130 43'N and 15° 14' N and longitudes

77° 55' E and 79°'E. The district spreads towards north beneath the western slopes of the Eastern Ghats as a rough parallelogram bent deeply in its southern, western and northern boundaries.

THE TERRAIN :

This district is relatively elevated in the north and west and the altitude gradually declines from north-west to south-east. The district can be topographically divided into three natural divisions namely, Western plains, Eastern Valley, and Southern Plateau.

SLOPE :

The general pattern of slope of the landforms in Cuddapa district showed the most rugged feature in patches found in scattered distribution.

DRAINAGE SYSTEM :

The Cuddaph district is mainly drained by the river .Pennar and its numerous tributaries and many innumerable streams.

SOILS :

The predomninant soils of the district are red accounting for 53 per cent and black soils 47 per cent of the geographical area of the district. The spatial distribution of these soils showed that red loam and red clay soils are found largely in eastern valley region, red sandy soils in southern plateau region and the black soils in western plains of the district.

CLIMATE :

Cuddapah district has the monsoon type of tropical cliamte. This region comes under the semi-arid type climate of the Deccan plateau. High temperature, high evapotranspiration and low precipitation are the chief characteristics of semi-arid climate of this region.

VEGETATION :

Cuddapah is one of the important district of the State in respect of the forest cover. The forest cover accounts for 31.3 per cent of the total geographical area of the district.

SEASONAL DISTRIBUTION OF RAINFALL, RAINFALL INTENSITY, RAINFALL VARIABILITY AND RAINFALL RATIO

Winter Season: During winter season, the rainfall occurence is very erratic. The amount of rainfall recorded is very insignificant. In winter season, the average rainfall varies from 6 to 17mm. The highest rainfall of 17mm. is found in Rajampet and the lowest of 6mm. in Jammalamadugu and Proddatur stations. The districts average rainfall is 9.9mm. The high amount of rainfall [>15mm.] is noticed in south-eastern part of the district while the low amount of rainfall {<10mm.} in north and north-western parts of the district.

The spatial distribution of rainfall intensity reveals that the maximum rainfall intensity is found in south-eastern part of the district. In central pockets of the district, the intensity ranges from 13 to 15 mm. per rainy day. The variability of rainfall in winter season varies from 107 to 286 per cent in the district. A maximum of 284 per cent is noticed in Proddatur and a minimum of 197 per cent in Rajampet. The spatial distribution of rainfall variability denotes that the maximum of more than 250 per cent is found in northern part of the district and a munimum of less than 250 per cent in southern part of the district.

The highest rainfall ratio of about 2,447 per cent has occurred in Jammalamadugu in contrast to the lowest ratio of about 910 per cent in Pulivendula. High rainfall ratio {> 1500 per cent} is found in northern part of the district.

TABLE 1 : MEAN WINTER RAINFALL DISTRIBUTION, RAINY DAYS, RAINFALL INTENSITY, RAINFALL VARIABILITY AND RAINFALL RATIO IN CUDDAPAH DISTRICT.

Station	Mean rainfall in mm.	Average No. of rainy days	Rainfall intensity in mm/ rainy day	Rainfall variability in {%}	Rainfall ratio
Cuddapah	9.66	0.70	13.80	205	1057
Rayachoty	10.06	0.78	12.89	199	1097
Kamalapuram	7.30	0.51	14.31	204	1075
Rajampet	16.82	0.92	18.28	197	1050
Sidhout	14.0	0.93	15.05	218	1555
Badvel	11.28	0.73	15.45	204	1151
Jammalamadugu	5.73	0.47	12.19	234	2447
Proddatur	6.29	0.43	14.63	286	2100
Pulivendula	7.72	0.59	13.06	198	910
Average	9.87	0.67	14.41	216	1382

The low ratio of less than 1,000 per cent is noticed in north-western part of the district. There are two anomalies found in the rainfall ratio values. The two anomalies stood side by side. The study of winter rainfall ratio and variability values indicated that there is greater variability and instability of rainfall.

Summer Season: During summer season the rainfall occurrence is also insignificant and irregular. However, the amount of rainfall occurrence in this season is largely due to conventional effect. In this season, the average rainfall of the district is 65.7 mm. The highest rainfall is noticed in Rajampet {72 mm.} while the lowest in Kamalapuram {56 mm.}. High rainfall of more than 70 mm. is found in south-eastern part of the district.

The rainfall intensity varies from 15 to 17 mm. per rainy day. Rajampet has the highest intensity of 17 mm. per rainy day and Pulivendula has the lowest of 15 mm. per rainy day. The spatial distribution of rainfall intensity indicates that in south-eastern part of the district, the maximum of more than 17 mm. per rainy day is noticed.

The variability of rainfall during this season denotes that the highest of 95 per cent is found in south-eastern part and the lowest of 57 per cent in north-western part of the district.

The rainfall ratio denotes that the highest of 561 per cent is noticed in Rajampet and the lowest of 246 per cent in Pulivendula. In the north-eastern part of the district the rainfall ratio is high (> 500%). Rainfall ratio with less than 300 per cent is found in north-western part of the district. The analysis of rainfall variability and ratio values indicated that the rainfall during this season is unstable.

TABLE 2: MEAN SUMMER RAINFALL DISTRIBUTION, RAINY DAYS, RAINFALL INTENSITY, RAINFALL VARIABILITY AND RAINFALL RATIO IN CUDDAPAH DISTRICT.

Station	Mean rainfall in mm.	Average No. of rainy days	Rainfall intensity in mm/ rainy day	Rainfall variability in {%}	Rainfall ratio
Cuddapah	4.10	15.18	62.22	87.64	847
Rayachoty	4.39	15.71	68.92	79.96	891
Kamalapuram	3.58	15.69	56.18	81.89	1169
Rajampet	4.15	17.44	72.36	99.26	894
Sidhout	4.35	15.75	68.70	88.98	1059
Badvel	3.91	15.96	62.41	88.68	885
Jammalamadugu	4.66	14.58	67.93	71.11	1209
Proddatur	4.28	14.63	62.61	81.57	1089
Pulivendula	5.00	13.93	69.64	56.86	536
Average	4.26	15.43	65.67	81.33	953

Southwest Monsoon Season: The Southwest monsoon is most important for widespread occurrence of rainfall in Cuddapah district. Nearly half of the district's average rainfall is received in this season. Due to geographical location of the district under rain-shadow region of Nallamalai, Velikonda and Seshachalam hills, the total rainfall recived in this season is not sufficient for agricultural activities. The September month of this season is important as it brings the highest rainfall in the district. During this season also the rainfall distribution is uncertain and spatially variable. The average rainfall of the district in this season is 392 mm. but it varies from 331 mm. to 461 mm. The spatial distribution of rainfall depicts that a maximum of more than 400 mm. is found in north and central parts of the district and a minimum of less than 350 mm in north-western part of the district. In south and north-eastern parts of the district, it ranges from 350 to 400 mm.

The rainfall intensity varies from 14.1 to 18 mm. per rainy day. The highest rainfall intensity of 18 mm. per rain day is found in Jammalamadugu and the lowest of 14.1 mm. per rainy day in Badvel and Rayachoty. The spatial distribution of rainfall intensity depicts that the maximum intensity is noticed in northern region and minimum of 14.1 mm. per rainy day in southwestern region in the district. In central part of the district, it ranges from 15 to 17 mm. per rainy day.

The rainfall variability during the southwest monsoon is very low due to high rainfall occurrence. It ranges from 33 to 41 per cent. The highest rainfall variability is found in

TABLE 3

MEAN SOUTHWEST MONSOON RAINFALL DISTRIBUTION, RAINY DAYS, RAINFALL INTENSITY, RAINFALL VARIABILITY AND RAINFALL RATIO IN CUDDAPAH DISTRICT

Station	Mean rainfall in mm	Average no. of rainy days	Rainfall intensity in mm/rainy day	Rainfall variability (in %)	Rainfall ratio
Cuddapah	461.12	30.32	16.69	36	165
Rayachoty	362.56	25.73	14.09	41	166
Kamalapuram	393.24	24.68	15.93	37	172
Rajampet	364.97	23.64	15.44	33	143
Sidhout	456.30	29.24	18.15	36	213
Badvel	374.11	25.22	11.20	35	213
Jammalamadugu	384.03	21.78	17.63	38	213
Proddatur	401.36	24.58	16.33	39	145
Pulivendula	330.51	20.93	15.81	40	144
Average .	392.00	25.12	15.70	37	175

Rayachoty and the lowest (33%) in Rajampet. The district's average rainfall variability is 37 per cent. The spatial distribution of rainfall variability denotes that the maximum of more than 40 per cent is noticed in south-western and the minimum of 33 per cent in south-eastern parts of the district.

The rainfall ratio during this season varies from 143 to 213 per cent. The highest of 213 per cent is found in Sidhout and Jammalamadugu stations and the lowest of 143 per cent in Rajampet. The spatial distribution denotes that the maximum of 200 per cent is noticed in north-western and north-eastern part of the district. The minimum of less than 150 per cent is found in south-eastern part of the district. The analysis of the rainfall variability and rainfall ratio values indicated that the occurrence of rainfall in this season is stable to a significatnt extent.

Northeast Monsoon Season: Northeast monsoon is also another important rainy season in the district. The total rainfall in this season is low compared to the southwest monsoon. October is an important rainy month of this season. The district receives one-fourth of the total annual rainfall during this season. The rainfall varies from 166 to 324 mm. The highest rainfall of 324 mm. is noticed in Rajampet and the lowest of 166 mm. in Jammalamadugu. The district's average rainfal is 229.8 mm. The maximum of more than 300 mm. is found in south-eastern part of the district and the mninimum of less than 200 mm. in north and north-western parts of the district.

The rainfall intensity varies from 11.2 to 22 mm. per rainy day. The spatial distribution of rainfall intensity denotes that a maximum of more than 20 mm. per rainy day is found in south-eastern part and a minimum of less than 15 mm. per rainy day in north-eastern part of the district.

The rainfall variability reveals that the highest variability of 71 per cent is found in Jammalamadugu while the lowest of 46 per cent in Sidhout. The spatial distribution of rainfall variability depicts that a maximum variability is found in north-western portion of the district and minimum of less than 50 per cent in the central part of the district.

The spatial distribution of the ratio value reveals that a maximum of more than 500 per cent rainfall ratio is found in north-western part and a minimum of less than 300 per cent is found in south and central parts of the district. In northern part of the district, it varies from 300 to 500 per cent. The values of the rainfall variability indicate that there is moderate stability in the rainfall occurrence but the ratio values depict that there is instability in rainfall occurrence.

Annual: The average annual rainfall of the district is 647.6 mm. But the highest rainfall of 834 mm. is found in Sidhout and the lowest of 590 mm. in Pulivendula.

The spatial distribution of rainfall discerns that a maximum of more than 800 mm. is noticed in south and nort-eastern parts of the district. Less than 600 mm. of rainfall is found in north-western portion of the district. The average annual rainfall decreases from east to west.

The highest rainfall intensity is found in Rajampet (17.1 mm per rainy day) and the lowest intensity (15.30 mm. per rainy day) in Rayachoty. The distribution of rainfall intensity denotes that a maximum of above 17 mm. per rainy day is found in south-eastern part and a minimum of less than 16 mm. per rainy day in south-western part of the district.

The annual variability of rainfall ranges between 26 and 49 per cent. The highest variability of 49 per cent is found in Badvel and the lowest 26 per cent in Cuddapah. The spatial distribution of rainfall variability depicts that a maximum of more than 40 per cent if found in north- eastern side and a minimum of less than 30 per cent in central part of the district.

The annual rainfall ratio varies from 106 to 335 per cent. The highest rainfall ratio of 335 per cent is noticed in Sidhout and the lowest of 106 per cent in Proddatur. A maximum of more than 200 per cent rainfall ratio is found in central part of the district while a minimum of 106 per cent in northern part of the district. The annual values of rainfall variability indicate that there is more or less stability in rainfall occurrence but the rainfall ratio values depict that there is instability in rainfall occurrence.

DISTRIBUTION OF SEASONAL RAINFALL FREQUENCY:

Winter: The analysis of rainfall frequency for the winter season indicated that there had been very high departure from the normal rainfall. In about 54 to 61 years the departure of rainfall is one-fourth from the normal. The number of years witnessing rainfall which exceeded the normal varied from 17 to 25. The study has revealed that there has been much variation in the occurrence of rainfall and it is found that the 70 per cent of the total years showed a rainfall which is less than the normal. This condition is presumed to be due to cold climate conditions prevailing in winter period.

Summer: During summer season, the rainfall occurrence far below the normal is noticed

TABLE 4

MEAN NORTHEAST MONSOON RAINFALL DISTRIBUTION, RAINY DAYS, RAINFALL INTENSITY, RAINFALL VARIABILITY AND RAINFALL RATIO IN CUDDAPAH DISTRICT.

Station	Mean rainfall in mm	Average no. of rainy days	Rainfall intensity in mm/rainy day	Rainfall variability (in %)	Rainfall ratio
Cuddapah	322.02	13.96	16.69	46.96	242
Rayachoty	230.77	14.17	16.29	55.25	347
Kamalapuram	179.41	24.68	15.85	57.81	333
Rajampet	324.45	14.86	21.83	51.67	278
Sidhout	294.94	16.25	18.15	45.96	210
Badvel	290.76	15.27	2.11	49.47	213
Jammalamadugu	166.21	9.76	17.03	71.36	548
Proddatur	167.37	10.41	16.08	57.53	310
Pulivendula	182.62	11.57	15.78	55.42	246
Average	229.84	14.54	15.53	54.60	303

TABLE 5

MEAN ANNUAL RAINFALL DISTRIBUTION, RAINY DAYS, RAINFALL INTENSITY,RAINFALL VARIABILITY, AND RAINFALL RATIO IN CUDDAPAH DISTRICT.

Station	Mean rainfall in mm	Average no. of rainy days	Rainfall intensity in mm/rainy day	Rainfall variability (in %)	Rainfall ratio
Cuddapah	765.01	45.61	16.77	26	123
Rayachoty	672.35	43.94	15.30	31	161
Kamalapuram	636.13	40.20	15.82	28	118
Rajampet	778.60	45.41	17.14	30	177
Sidhout	833.95	50.73	16.44	27	335
Badvel	738.33	45.14	16.36	49	173
Jammalamadugu	623.90	39.56	15.77	29	172
Proddatur	637.62	39.71	16.06	30	106
Pulivendula	590.00	38.09	15.49	32	175
Average	647.59	42.60	16.12	31	171

only in a few years. It varied from 4 to 12 years. The study has revealed that in about 49 to 56 years the rainfall received was less than the normal. In other words, the rainfall departure from the normal is found high. However, the conventional activity prevailed in this period led to the probable increase of rainfall in about 31 to 39 years above the normal when compared to the winter period.

Southwest Monsoon: In about 43 to 57 years, the rainfall is less than the normal and in about 36 to 45 years the rainfall is found above the normal. The study has revealed that there has not been much variation in the rainfall occurrence during the southwest monsoon period.

Northeast Monsoon: In about 39 to 50 years, the departure of rainfall from normal is noticed. But in about 35 to 41 years, the rainfall above the normal is found. In otherwords, the frequency of rainfall occurrence in this period is not highly variable.

Annual Rainfall Frequency: The annual analysis of rainfall frequency showed that the departure of rainfall from the normal is low (about 12 to 21 years) In about 29 to 36 years the rainfall frequency is normal. The number of years varying from 36 to 44 showed the rainfall above the normal. The results of the annual rainfall frequency revealed that in majority of the years rainfall occurrence was normal or above the normal. The number of years which fall below the normal are very few. In other words, the annual rainfall during the period of study seem to be more stable with a few variations from the normal.

The analysis of seasonal rainfall has revealed that the rainfall received in the district is high in southwest monsoon followed by northeast monsoon. In summer, the rainfall received is moderate and varied from 63 mm. to 180 mm. The annual rainfall distribution has revealed that the rainfall increases from east to west. There has not been much variation in rainfall intensity and average number of rainy days. But the rainfall decreases towards westwards with the decrease in number of rainy days. The rainfall intensity is high in the western portion. The Variability values have not shown much variations in the annual pattern. The ratio values showed that there is low to moderate stability. The frequency of rainfall occurrence also does not show much variations in the occurrence of rainfall and the departure from normal is very low.

DECADAL VARIATION IN RAINFALL DISTRIBUTION, RAINFALL INTENSITY, RAINFALL VARIABILITY AND RAINFALL RATIO :

The decadal variation in rainfall distribution, rainfall intensity, rainfall variability and rainfall ratio are carried out to understand the trend of the rainfall during the 80 years period of study. The analysis has been carried out on seasonal and annual basis. (Tables 6, 7, 8, 9).

Decadal Analysis of Rainfall Distribution (Season-wise) :

The study of rainfall trends from 1901 to 1980 during winter period indicated that in the first 3 decades the rainfall received in the district is good and ranged from 11 mm. to 41.7 mm. But from 1941 to 1980 there has been a fall in the rainfall during winter season. In a few locations like Jammalamadugu, Kamalapuram, Badvel and Proddatur there was no rainfall during winter period. The spatial distribution of rainfall during different decades indicated that from 1911 to 1920 the rainfall is fairly distributed without much variation in the isohyetal distribution. But in 1930, the rainfall received was less than 15 mm. in the central and western pockets and it was more than 25 mm. in the south-eastern part of the district. The rainfall received was less than 5

TABLE 6

ANNUAL DECADAL RAINFALL IN CUDDAPAH DISTRICT

(Figures in mm)

Station	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1988
Cuddapah	796.42	763.27	754.27	684.28	741.05	824.08	823.90	785.97	698.83
Rayachoty	705.15	607.87	682.88	667.18	674.80	705.30	697.60	742.04	619.46
Kamalapuram	705.23	177.34	605.92	596.29	553.42	701.61	702.87	635.41	610.34
Rajampet	728.14	850.22	728.70	726.62	854.79	369.15	315.88	719.33	779.23
Sichout	868.63	825.80	823.24	734.36	802.67	826.12	852.55	883.19	889.06
Badevel	746.76	723.00	675.41	686.33	705.56	746.76	769.12	835.57	738.30
Jamalamadugu	631.83	617.52	570.48	579.81	571.35	661.88	744.60	613.73	623.89
Proddatur	673.43	617.70	596.11	604.98	608.18	703.34	636.05	624.12	683.96
Pulivendula	558.47	598.30	556.95	486.59	610.90	620.41	750.30	503.58	128.74

TABLE 7

ANNUAL DECADAL RAINFALL INTENSITY IN CUDDPAH DISTRICT

(All values in mm per rainy day)

Station	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1988
Cuddapah	18.27	17.55	13.09	17.26	19.56	17.31	16.00	16.65	20.84
Rayachoty	17.00	13.82	14.11	15.81	12.71	16.03	15.00	15.75	16.74
Kamalapuram	18.00	15.00	14.71	15.69	13.27	17.07	15.31	16.00	20.76
Rajampet	16.33	18.40	15.77	15.83	15.95	22.70	15.96	15.97	22.19
Sidhout	18.40	17.70	15.27	14.45	15.50	12.33	17.35	18.67	22.24
Jammalamadugu	15.96	15.63	15.85	15.25	13.07	17.69	18.07	14.47	20.59
Proddatur	16.59	15.58	15.89	16.35	13.98	16.83	15.22	15.68	18.00
Pulivendula	15.26	15.22	15.82	14.75	14.04	15.02	14.79	18.13	12.16

TABLE 8

ANNUAL DECADAL CO-EFFICIENT OF VARIABILITY IN CUDDAPAH DISTRICT

(Figure in %)

Station	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1988
Cuddapah	38	22	24	24	18	29	13	20	31
Rayachoty	42	29	20	32	25	32	23	23	20
Kamalapuram	31	22	21	27	26	30	18	27	31
Rajampet	32	31	22	26	35	36	26	23	19
Sidhout	29	29	22	18	19	31	25	23	36
Badvel	29	31	25	14	22	23	18	33	23
Jammalamadugu	25	24	17	26	22	36	30	32	25
Proddatur	33	24	17	25	31	24	28	31	33
Pulivendula	31	30	23	31	25	23	29	35	17

TABLE 9

ANNUAL DECADAL RAINFALL RATIO VALUES IN CUDDAPAH DISTRICT

(Figures in %)

Station	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1988
Cuddapah	238	76	90	77	53	90	46	72	110
Rayachoty	147	85	76	113	76	115	78	70	68
Kamalapuram	94	71	77	98	70	87	61	104	93
Rajampet	131	107	90	85	115	126	79	84	37
Sidhout	105	97	83	58	62	120	85	76	119
Badvel	131	77	24	44	63	82	63	121	75
Jammalamadugu	64	80	58	76	73	135	110	104	66
Proddatur	95	70	36	84	84	115	78	114	107+
Pulivendula	90	69	86	100	87	72	86	126	60

mm. in western and north-western pockets of the district and more than 10 mm. towards south-eastern part in 1940. During 1950 the major part of the district received 5 to 10 mm. Unfortunately during 1961 to 1980 the rainfall received was less than 3 mm. in many areas of the district. The analysis of rainfall during winter period indicated that there has been a decreasing trend from 1911-1980.

During summer period there has not been much variation in the rainfall distribution except in the decade 1951-60. During this decade the rainfall received is higher than the normal in all the stations of the district. During 1901-1910 the rainfall received is lower than other decades and varied from 38.4 to 73.6 mm.

Decadal analysis of annual rainfall from 1901 to 1980 has also not shown any significant changes. During 1910, 1920 and 1930 and 1950 and 1980 there was more or less similar pattern of distribution of rainfall. But in 1931-1940 there was a decrease in the rainfall, in 1951-60 and 1961-70 there was a slight increase in the rainfall. The analysis of annual rainfall trend indicated a decrease in rainfall, during 1931-40 and increase in rainfall during 1951-70.

DECADAL ANALYSIS OF RAINFALL INTENSITY :

The decadal analysis of rainfall intensity of the winter season showed a low intensity of rainfall during 1931-40 and 1951-80 while the intensity of rainfall was high during 1901-1930. During 1941-50 the values of intensity of rainfall were moderate. There was a trend of decrease in the intensity of rainfall during 1931-40 followed by an increase from 1941 to 1950 and again a decrease from 1951 to 1980.

During summer season the decadal variation in rainfall intensity showed an increasing trend in 1910, 1920, 1940, 1950 and 1960. During 1950 and 1980 there was a fall in the intensity of rainfall. However, in 1930 and 1970 the trend lies in between the fall and rise. The isoline distribution has not been uniform in all the decades and it was very much uneven in 1960.

During southwest monsoon period the trend analysis of intensity of rainfall indicated an increase during 1920, 1930 and 1960. During 1950 and 1970 the intensity of rainfall was low. Irregular distribution of isolines revealed that there was no uniform pattern of distribution of intensity of rainfall. The isolines have also showed a fall in the intensity of rainfall in 1950, 1970 and 1980.

During northeast monsoon period the intensity of rainfall showed a fall in the trend during 1930, 1940 and 1980. During 1960 the fall was low. The isoline distribution was also not uniform and regular.

DECADAL ANALYSIS OF CO-EFFICIENT OF VARIATION OF RAINFALL :

The decadal analysis of co-efficient of variation of rainfall during winter period has showed higher variability values in the decades of 1910 and 1950. During 1970 the variability values found in the district were low. Variability values were moderate during the decades of 1930, 1940, 1960, 1970 and 1980. The trend of these values showed a fall in 1970 and a raise in 1950. The isolines are uneven and do not show a uniform distribution. The variability values showed a greater instability during all the decades.

The values of co-efficient of variability of rainfall are comparatively low during summer period. High variability values ranging from 75 to 100 per cent were noticed during 1930 and 1940. The distribution of isolines was uneven and irregular during 1930 and 1940. In many decades the variability values showed

moderate stability in the rainfall distribution.

The annual values of rainfall variability showed a decreasing trend during 1910, 1930, 1970 and 1980. The values were found high during 1950. However, they were moderate in 1920 and 1940. The distribution of isolines were uneven and they have not shown any significant degree of uniformity in different decades. But the values of rainfall variability have described that there has been a greater stability in the distribution of decadal rainfall.

DECADAL ANALYSIS OF RAINFALL RATIO :

The decadal analysis of rainfall ratio during winter period has revealed that low rainfall ratio was noticed in 1920, 1930 and 1940. Moderate rainfall ratio values were found during 1950-70 while in 1980 the ratio values were high. The trends of rainfall ratio indicate that there has been a trend of decrease in 1920 followed by a slight increase in 1930 and 1940. However, from 1950 onwards there has been a high increasing trend in the rainfall ratio values. The isolines are not shown any uniform and regular distribution of ratio values in the district. The high values during winter period in different decades revealed that there has been greater instability in rainfall distribution.

In summer period the decadal analysis of rainfall ratio represented low values in the decades of 1920 and 1970, moderate values during 1930-1960; and high values in 1910. The trend of rainfall ratio has revealed that there has been a trend of decrease in 1920 followed by a trend of increase during 1930-60; and a trend of decrease in 1970 and increase in 1980. The high values of rainfall ratio also confirmed that the rainfall is not stable during summer period.

The decadal analysis of annual rainfall ratio indicated that the values were low in the decades of 1930, 1940 and 1970, moderate values in the decades of 1920, 1940, 1950 and 1960, and high rainfall ratio values in the decades of 1910 and 1980. The trend of decrease was found in 1930 and 1970 and in between there was a slight increase in the trend of rainfall ratio. The annual decadal values of the rainfall ratio indicated a greater stability of rainfall during 1920, 1930, 1940, 1950, 1960 and 1980. There has been an instability in rainfall during 1910 and 1980. The study has revealed that in majority of the decades, there has been a greater stability in the distribution of rainfall in the district.

SELECTED REFERENCES

Anantakrishnan R. and Rajagopalachari, P. J. (1964). Pattern of Monsoon Rainfall Distribution over India and Neighbourhood, *Proceedings of the Symposium on Tropical Meteorology*, Ratoura, Newzealand, Virginia.

Bedekar, V. C. and Benerjee, A. K.(1969). A Study of Climatological and other Rainfall Patterns over Central India, *Indian Journal of Meteorology and Geophysics*, Vol. 26, p. 214.

Bhargava, P. N. et al., (1964). *Statistical Studies on the Behaviour of Rainfall in a Region in Relation to a Crop*, A Monograph Published by I.C.A.R., New Delhi.

Bishnoi, O.P. (1975). A Study of the Realiability, Deficiencies and Excesses of Rainfall over the Haryana State, *Indian Journal of Meteorology and Geophysics*, Vol.26, pp. 211-214.

Dikshit, K. R. (1979). Anamolies in the Distribution of Rainfall on the West Coast of India, *The Indian Geographical Journal*, Vol. 54, No. 1.

George, C. J. and Vasudevan, V. K. (1963) Some Features of Rainfall over a Belt in Madras State, *Indian Journal of Meteorology and Geophysics*, Vol. 14, pp. 190-195.

Parthasarathy, B. and Dhar, O. N. (1970). A Study of Trends and Periodicities in Seasonal and Annual Rainfall of India, *Indian Journal of Meteorology and Geophysics*, Vol. 27, pp. 23-28.

Raghavendra, V. K.(1974). Trends and Periodicities of Rainfall in Sub-Divisions of Maharashtra, *Indian Journal of Meteorology and Geophysics*, Vol. 25, pp. 197-210.

Ramakrishna Prasad, K. P. and Narayana, J. (1967). Study of Fifty years Rainfall of Vishakapatnam, *Memories of Indian Metereological Department*, Vol. XXX, Part-IV.

Rao, B. V. R. and Rao. E. V. M. (1971). The Maximum Expected Rainfall During the Main Crop Growing Season in Mysore State, *The Mysore Journal of Agricultural Science*, Vol. V, pp. 272-282.

Rao, W. V. M. and Thimmegowda, S. (1979). Use of Weekly Normal Weather Parameters for Cropping Pattern, *Current Research*, Vol. 8, pp. 195-196.

Reddy, N. B. K. (ed.) (1979). *Proceedings of All India Symposium on Drought Prone Areas of India*, Rayalaseema Geographical Society, S. V. University, Tirupati.

Saxena, A. et al. (1979). Rainfall Pattern and Crop Planning. *Indian Journal of Agricultural Research*, Vol.13, pp. 208-214.

Sinha, K. L. (1959). Seasonal Features of the Spatial Distribution of Rainfall in Pre-Partition India, *Indian Journal of Meteorology and Geophysics*, Vol. 10, pp. 47-56.

Sreedharan, P. C. and Ramachandra, S. (1970). Prediction of Fortnightly Rainfall for the Crop Growing Season in Hebbal Region, *The Mysore Journal of Agricultural Science*, Vol. IV. pp. 8-13.

Srinivasan, M.V. (1935). Agricultural Geography of the Anantapur District, *Journal of the Madras Geographical Association*, Vol. 9, p. 27

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