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DROUGHTS OVER ANDHRA PRADESH

1. The impact of Pacific Ocean temperatures on droughts over India has been studied by many workers. However, the impact on smaller regions is also a topic of interest and study.

Rainfall or drought over India in relation to El Nino have been studied by Mooley (1997), Kane (1998) etc. Probability of occurrence of drought in various subdivisions in India and the impact of El Nino on it was recently studied by Sinha Ray and Shewale (2001). A statistical analysis of influence of El Nino on monsoon rainfall over Tamilnadu was studied by Rangaswamy (2000); Mooley (1984); Parthasarathy *et al.* (1987) studied large scale drought over India. Gore and Thapliyal (2000) studied dry spells over Maharashtra. The trend analysis and variability of rainfall have been studied by many scientists. Rao (1958) studied trends in rainfall in Rajasthan. Chowdhury and Abhyankar (1979) studied trend in rainfall over Gujarat state. Study by Srivastava *et al.* (1998) indicated no trend in all India summer monsoon rainfall. In the present study an attempt has been made to identify large scale droughts and the trend if any over Andhra Pradesh, their linkage with SST anomalies over Pacific region and all India droughts and the analysis of decadal average of large scale droughts.

2. *Data and Methodology* - The basic data used comprises of daily rainfall data for Andhra Pradesh for the period 1901-2000 collected from National Data Centre, office of Additional Director General of Meteorology (Research), Pune. The SST anomalies over Pacific (source, NOAA/NWS/ NCEP, USA) were used for the period 1950-2000 for examining the association between Pacific SST on the droughts over Andhra Pradesh. A meteorological drought over an area is defined as a situation when rainfall over that area is less than 75% of the climatological normal. By using seasonal rainfall departure for southwest monsoon season for the period 1901-2000, the years with deficit rainfall more than 25% for different districts in Andhra Pradesh have been identified as drought years for districts. These are further classified as moderate when the percentage rainfall deficit is 26-50 % and severe, if deficit is more than 50 %. If in an year 25% or more of the area of the state is affected by drought, then that year is considered as one in which the state suffered from large scale drought. The worst drought affected years were demarcated (marked with star) out of the large scale drought years, when the area affected by drought exceeded 50% of the area of the state. A drought for the country as a whole is defined when total area of the country affected by drought is exceeded by 20% of the

country's area and deficit of the rainfall during Southwest monsoon season for the country should be more than 10%. The correlation coefficient between Pacific temperature anomalies in Nino 1+2 (0°-10° S, 90° W-80° W), Nino3 (5° N-5° S, 150° W-90° W) and Nino4 (5° N-5° S, 160° E-150° W) regions in different months and seasons and area affected by drought over Andhra Pradesh during 1950-2000 have been worked out. Trends for the area affected by drought over Andhra Pradesh state and the subdivisions were studied by applying Mann Kendall (1966) Rank statistics test of the area affected by drought over Andhra Pradesh during the period 1901-2000. The 11 years running means of the area affected by drought were considered to remove the erratic cycles upto 11 years.

3. *Results & discussion* - Normal seasonal rainfall during southwest monsoon season over Andhra Pradesh varies from 30-100 cm. The coefficient of variation varies from 20% to 40%. There are 27 large scale droughts identified over Andhra Pradesh during 1901-2000 and out of them 12 drought years are worst droughts (marked with star in the table) when the area affected by drought exceeded 50% of the area of the state. The decadal variation of large scale droughts is given in Table 1.

The Table 1 shows that : (i) On an average one worst drought is noticed in each decade, (ii) Highest of 3 worst droughts are in decade 1911-1920 and (iii) Highest of 4 to 5 large scale droughts are in decades 1911-1920 and 1991-2000.

The drought years in India are : 1901, 1904, 1905, 1907, 1911, 1913, 1915, 1918, 1920, 1925, 1939, 1941, 1951, 1965, 1966, 1968, 1972, 1974, 1979, 1982, 1985, 1987, 2000. The 13 drought years over Andhra Pradesh are common with all India drought years (underlined). As such probability of large scale drought over Andhra Pradesh could be assigned to be 57% whenever there is drought over the country.

The El Nino years identified by Mooley (1997) since 1900 are 1902, 1905, 1911*, 1914, 1918*, 1923*, 1930*, 1932, 1939*, 1941*, 1951, 1953, 1957, 1965, 1969, 1972*, 1976, 1982, 1987*, 1991 and the latest year is 1997*. The 9 large scale drought years marked with star are common with El Nino years showing probability of large scale droughts over Andhra Pradesh in El Nino years as 41%.

The impact of Pacific Ocean temperatures on the droughts over Andhra Pradesh is examined by considering correlations between SST anomalies over Pacific during different seasons and months and area affected by drought over Andhra Pradesh state for years 1950 to 2000 as shown in Table 2. The correlation is positive and

TABLE 1

Drought years over Andhra Pradesh

1901 to 1910	1911 to 1920	1921 to 1930	1931 to 1940	1941 to 1950	1951 to 1960	1961 to 1970	1971 to 1980	1981 to 1990	1991 to 2000
1901	<u>1911*</u>	1922*	1937	<u>1941*</u>	1952*	<u>1968*</u>	1971*	1984	1992
<u>1904*</u>	<u>1913</u>	1923	<u>1939*</u>	1948			<u>1972*</u>	<u>1985</u>	1993
	<u>1918*</u>	1930					<u>1974</u>	<u>1987</u>	1994*
	1920*						1977		1997
									1999
Worst droughts									
1	3	1	1	1	1	1	2	-	1

Underline indicates all India drought occurrence.

TABLE 2

Correlation of pacific temperature anomalies vs drought area of Andhra Pradesh 1950-2000

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Nino 1+2											
-0.13	-0.13	0.01	-0.07	-0.03	0.03	0.07	0.05	0.17	0.26	0.2	0.18
Season											
Winter			Pre-monsoon			Monsoon			Post-monsoon		
-0.1			0.0			0.08			0.22		
Nino 3											
-0.23	-0.23	-0.14	0.05	0.07	0.05	0.16	0.25	0.22	0.22	0.25	0.20
Season											
Winter			Pre-monsoon			Monsoon			Post-monsoon		
-0.2			0.0			0.18			0.23		
Nino 4											
-0.22	-0.15	-0.23	-0.03	0.0	0.17	0.13	0.24	0.17	0.24	0.27	0.28
Season											
Winter			Pre-monsoon			Monsoon			Post-monsoon		
-0.2			-0.1			0.19			0.27		

significant during post monsoon season at 95% level of confidence in Nino4 region and at 90% level of confidence in Nino3 region. The month wise negative correlations are significant at 90% level of confidence during March in Nino4 region and during January and February in Nino3 region. The month wise positive correlations are significant at 90% level of confidence during October in Nino 1+2 region, during August,

October, November and December in Nino4 region and during August and November in Nino3 region. The correlations for November and December are also significant at 95% level of confidence in Nino4 region.

Mann-Kendall (WMO, 1966b) rank statistics is the simpler and is recommended for general use against trend alternatives. Therefore, Mann-Kendall rank statistics test

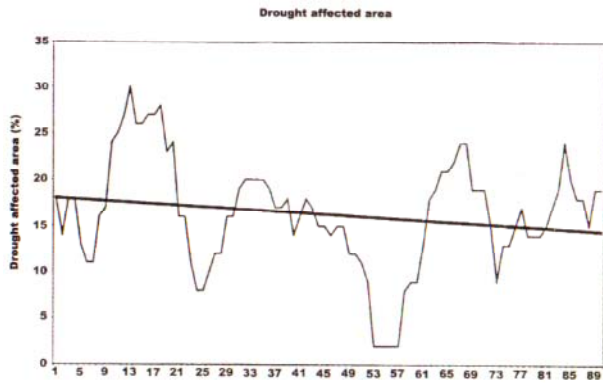


Fig. 1. Years moving average of drought affected area (%) over Andhra Pradesh state drought affected area

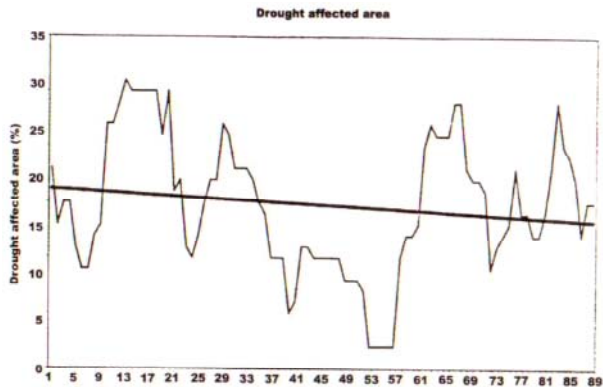


Fig. 2. Years moving average of drought affected area (%) over coastal Andhra Pradesh state drought affected area

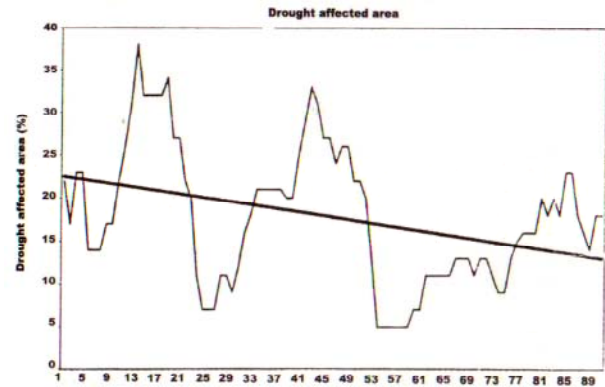


Fig. 3. Years moving average of drought affected area (%) over Rayalaseema

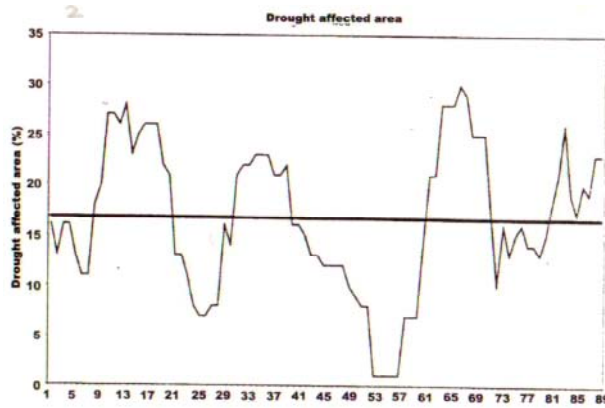


Fig. 4. Years moving average of drought affected area (%) over Telangana

was used for finding the trend in area affected by drought during 1901-2000 over Andhra Pradesh. No significant trend was noticed over the state as a whole and the subdivisions, *viz.*, Telangana and Coastal Andhra Pradesh. However, Rayalaseema showed significant decrease in trend during 1901-2000 (Figs. 1-4).

The important findings of the study are :

- (i) The correlation between Pacific SST and area affected by drought over Andhra Pradesh is positive and significant during post monsoon season in Nino4 and Nino3 regions.
- (ii) The month wise negative correlations between Pacific SST and area affected by drought over Andhra Pradesh are significant during March in Nino4 region and during January and February in Nino3 region.
- (iii) The month wise positive correlations between Pacific SST and area affected by drought over Andhra

Pradesh are significant during October in Nino1+2 region, during August, October, November and December in Nino4 region and during August and November in Nino3 region.

- (iv) No significant trend for the area affected by drought over Andhra Pradesh state was noticed. However, the only sub-division Rayalaseema showed significant decreasing trend during 1901-2000.
- (v) On an average one worst drought is noticed in each decade.
- (vi) The decades 1911-1920 and 1991-2000 had maximum frequency of large scale droughts.
- (vii) The probability of large scale drought over Andhra Pradesh is 57% in case of drought year over the country.
- (viii) The probability of large scale drought over Andhra Pradesh is 41% during El Nino years.

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