551. 526. 6 : 551.513.7 : 551.553.21 : 551.577 (548.1)

A STATISTICAL ANALYSIS OF INFLUENCE OF EL-NINO ON MONSOON RAINFALL OVER TAMIL NADU

1. Introduction

The rainfall variations in several regions of the globe are reported to be strongly associated with some natural causes like El-Nino (EN) Southern Oscillation (SO) and equatorial south eastern Pacific sea surface temperature (SST). The studies by Ramage and Hori (1981), and Ropelewski and Halpert (1987) reveal that heavy rains in Peru and in islands in equatorial Pacific as well as droughts in India, Indonesia, Australia etc. are associated with El-Nino.

In the Indian context the influence of El-Nino on rainfall has been studied by several researchers (Sikka, 1980; Mooley and Parthasarathy, 1983; Parthasarathy and Mooley, 1985; Sridharan and Muthusamy, 1990; Mooley, 1997).

The influence of El-Nino on weather and climate is not unique. It depends on the evolution of El-Nino, the intensity of El-Nino and the direction and strength of southern hemispheric trades in eastern Pacific. Hence, Mooley (1997) classified El-Nino events in combination with warming phase events in the equatorial southeastern (ESE) Pacific region and explored the relationship of such events with Indian Summer Monsoon Rainfall (ISMR).

Mooley (1997) termed the El-Nino in which the ESE Pacific region experienced warming phase as EW event and the one in which the ESE Pacific region did not experience warming phase as E events. He then examined the large scale and regional scale ISMR in EW events *viz-a-viz* E events. He reported that the percentage deficiency of monsoon season rainfall of the sub-divisions in northeast and central India in EW years was significantly higher than that in E years.

In the earlier studies area-average rainfall of India or sub- divisions of India for the summer monsoon season (June - September) was considered. It is well known that within an area there will be wide variation in rainfall but averaging will nullify such variations.

Hence, it is obvious that such averaging will mask the real influence of El-Nino on rainfall. Moreover, information on rainfall variations in smaller regions will be of much use in agricultural planning. Hence it would be appropriate if the rainfall of a location is taken as such and the relationship between rainfall and El-Nino is studied. Further, these studies do not take the normal (non El-Nino) years into account. In the present study such draw backs are overcome.

Fig. 1. Map showing selected rain gauge stations in Tamil Nadu

2. Data and methodology

The southwest monsoon (June - September) and northeast monsoon (October - December) rainfall data for 12 rain gauge stations of Tamil Nadu (Fig.1) for the period 1901-94 are used for this study. The rainfall data were collected from season and crop reports published by the Government of Tamil Nadu.

The years are classified as normal, EW, E and W (warming phase alone) years on the basis of Mooley's (1997) concept. The impact of El-Nino events as classified by Mooley on southwest and northeast monsoon rainfall of Tamil Nadu is examined using analysis of variance technique.

3. Results

3.1. *Southwest monsoon and El-Nino*

The mean rainfall (mm) for normal, EW, E and W years for the southwest monsoon (June - September) for different rain gauge stations in Tamil Nadu are given in Table 1. In the table the highest value is given subscript "a". The value which is significantly lower than that value is given superscript "b". The values with same subscript indicate that they are not significantly different from each other. The superscript "ab" indicates that the value is on par with values with superscript "a" as well as "b".

A decreasing trend in south west monsoon rainfall from normal to E (El-Nino only) years and from E years to EW (El-Nino + warming phase) years is observed in six out of 12 stations (Table 1). Compared to normal years the mean

TABLE 1

Mean rainfall (mm) during southwest monsoon (June- September) for different rain gauge stations in Tamil Nadu for the period 1901-94 based on Mooley's classification of El-Nino years

Rain gauge stations	Normal years	EW	E	W
Cuddalore	404.3[a]	343.2[b]	365.2[ab]	381.1[ab]
	(46.8)		(85.7)	(80.1)
Nagapattinam	311.5[a]	245.4[b]	254.8[ab]	259.5[ab]
	(44.3)		(81.0)	(75.7)
Chengalpattu	441.8[a]	370.3[b]	377.4[ab]	353.1[b]
	(58.1)		(104.5)	(97.8)
Ramanathapuram	179.9[a]	137.3[a]	183.8[a]	158.0[a]
Vellore	462.1[a]	394.7[b]	359.6[b]	350.0[b]
	(62.6)		(112.6)	(105.3)
Salem	376.7[a]	299.8[b]	322.4[ab]	306.4[ab]
	(53.7)		(96.5)	(90.3)
Tiruchi	301.6[a]	263.5[a]	257.4[a]	277.3[a]
Madurai	247.5[a]	210.3[a]	219.5[a]	213.1[a]
Kovilpatti	143.6[a]	139.7[a]	146.4[a]	142.2[a]
Thirunelveli	100.8[a]	80.1[a]	95.8[a]	89.1[a]
Coimbatore	180.1[a]	160.3[a]	184.4[a]	123.8[a]
Ooty	1056.4[a]	857.5[b]	1106.0[a]	1105.9[a]
	(140.4)		(246.9)	(240.1)
Tamil Nadu State	340.8[a]	298.2[a]	322.7[a]	321.4[a]

Same letters indicate that the means are on a par

Figures in parentheses are the critical differences for comparing mean of that category with EW mean.

TABLE 2

Mean rainfall (mm) during northeast monsoon (October- December) for different rain gauge stations in Tamil Nadu for the period 1901-94 based on Mooley's classifications of El-Nino years

Rain gauge stations	Normal years	EW	E	W
Cuddalore	579.0[a]	692.7[a]	677.8[a]	700.3[a]
Nagapattinam	643.7[a]	776.1[a]	778.4[a]	735.6[a]
Chengalpattu	660.9[a]	730.7[a]	642.1[a]	590.8[a]
Ramanathapuram	459.5[a]	487.3[a]	542.0[a]	492.5[a]
Vellore	397.2[a]	422.3[a]	352.9[a]	322.6[a]
Salem	316.7[a]	313.9[a]	306.4[a]	274.1[a]
Tiruchi	382.2[a]	496.6[a]	446.9[a]	383.7[a]
Madurai	409.5[a]	451.2[a]	408.2[a]	383.3[a]
Kovilpatti	387.3[a]	404.1[a]	384.4[a]	453.4[a]
Thirunelveli	428.1[b]	520.6[ab]	629.6[a]	523.1[ab]
	(95.6)		(171.7)	(160.6)
Coimbatore	308.4[b]	422.1[a]	251.0[b]	274.2[b]
	(79.4)		(140.3)	(140.3)
Ooty	484.8[b]	614.2[a]	512.8[ab]	428.9[b]
	(82.7)		(151.3)	(141.4)
Tamil Nadu State	444.2[b]	533.2[a]	494.4[ab]	457.2[ab]

Same letters indicate that the means are on a par

Figures in parentheses are the critical values for comparing the mean of that category with mean of EW years

rainfall is low during EW years in all 12 stations. However, the analysis of variance reveals that the difference is significant in only six out of 12 stations. It may be noted that these six stations are located in the northern part of Tamil Nadu (Hatched area in the map, Fig.1). The mean rainfall for E years is low compared to that of EW years in 10 stations. However, the difference is significant only for one station. For E years the mean rainfall is low compared to that of normal years in eight stations but the difference is significant only in one case.

Considering entire Tamil Nadu State, no significant difference in the mean rainfall of different categories is observed although the trend is declining one from normal to EW years.

3.2. *Northeast monsoon and El-Nino*

Similar analysis was carried out for north east monsoon also. The results are presented in Table 2 for different categories as defined earlier.

In two stations the mean rainfall is significantly more during EW years compared to normal years and in one station it is more during E years. It may be observed that among these three stations in one station the mean rainfall is significantly more in EW years than in E years and in two stations EW and E years are on a par.

Considering the State as a whole the mean rainfall is significantly high in EW years compared to normal years. The E years are on a par with EW and normal years.

4. Conclusion

The influence of El-Nino on the south west monsoon and north east monsoon rainfall is studied using the rainfall data of 12 rain gauge stations spread over Tamil Nadu state and by dividing the El-Nino events under different categories as suggested by Mooley (1997). Analysis of the data of individual stations and Tamil Nadu state as a whole brings out the following salient findings.

(*i*) El-Nino alone may not influence the variations in rainfall over a region of India. Along with El-Nino, the warming phase of the Pacific region has to be considered for such studies.

(*ii*) Apart from El-Nino and warming phase of the Pacific region some local factors seem to influence the variation in rainfall over Tamil Nadu since there are variations in the pattern of monsoon rainfall from station to station.

(*iii*) In El-Nino years in which ESE Pacific region experienced warming phase (EW years) northern parts of Tamil Nadu only experienced low rainfall during south west monsoon compared to normal years. During northeast monsoon high rainfall is observed only in the north-western part of Tamil Nadu in the EW years.

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