



Study on Correlation between Southwest and Northeast Monsoon Rainfall over Tamil Nadu

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Abstract:

In the present study 110 years (1900-2010) data is used for studying correlative effects between southwest (June-September) and northeast monsoon (October –December) rainfall over Tamil Nadu. For the period of different solar cycles, we compute the correlation coefficients using Spearman Rank technique. A correlation analysis between the two rainfall series revealed that the southwest monsoon rainfall is negatively correlated with that of the northeast monsoon rainfall. That is, an excess or deficit of southwest monsoon rainfall over this region is generally followed by an opposite tendency in the northeast monsoon rainfall. It also reveals that the rainfall in the two monsoons is not independent of each other. The negative rainfall relationship can be a useful tool in foreshadowing the northeast monsoon rainfall over Tamil Nadu, which is of considerable economic importance for this region.

Keywords: Correlation, southwest monsoon, northeast monsoon, Spearman's.

1.0 Introduction:

Over major parts of the Indian subcontinent, the southwest summer monsoon period (June to September) is the principal rainy season. However, during the autumn, the zone of maximum rainfall migrates to southern most India. Hence, the main season of rainfall over the southern parts of India is the northeast monsoon (October to December). This season is also termed as the retreating (southwest) monsoon season or the post-monsoon season. The rainfall in this season determines the agricultural production in this area. A considerable decrease in agricultural production over this region has been noted during seasons of below-normal northeast monsoon rainfall (Rao Krishna and Jagannathan, 1953). Whereas the variation of the southwest monsoon has been widely studied, as documented by numerous publications (e.g. Doraiswamy, 1946; Rao Krishna and Jagannathan, 1953; Rao, 1963; Rao and Raghavendra, 1971; Ramaswamy, 1972; Srinivasan and Ramamurthy, 1973; Krishnan, 1984; Raj and Jamadar, 1990; Sridharan and Muthusamy, 1990; Sigh and Sontakke, 1999; Kumar et al., 2003; Kripalani and Pankaj kumar, 2004). Therefore, it is worthwhile examining the northeast rainfall of Tamil Nadu.

Tamil Nadu, located in southeast peninsular India, receives the major part of its annual rainfall during the northeast monsoon season. Coastal Tamil Nadu receives about 60% of its annual rainfall and interior Tamil Nadu receives about 40-50% of annual rainfall during northeast monsoon (India Metrological department, 1973). In comparison with Indian summer monsoon, the Northeast monsoon is characterized by limited aerial extent and average lesser rainfall amount. The southwest monsoon, a part of the equatorial westerlies, is humid, unstable and of considerable vertical extent. On the other hand, the northeast monsoon, which is a part of the northeast trades is comparatively dry, stable and of lesser vertical extent, about 1 to 2 Km. As a result of the fundamental differences in the origin and structure of these two monsoons, Tamil Nadu receives varying amounts of rainfall during the two rainy periods. During northeast monsoon season, Tamil Nadu generally receives rainfall due to the formation of tough of low, cyclonic circulation, easterly waves, low pressure area, depression and cyclonic storm over Bay of Bengal, because, the northeast monsoon season is the major rainy season.

Rao (1953) observed that, in the same year, there is an indication that, a good northeast monsoon rainfall over Tamil Nadu is generally associated with deficit or normal southwest monsoon rainfall and vice versa. The vicissitudes of the rainfall of Tamil Nadu state has led to considerable and widespread interest among the public, farmers as well as in government circles in recent years, in view of the frequent failure of northeast monsoon rainfall over Tamil Nadu and the consequent water scarcity condition. In the present study, an attempt has been made to investigate whether there is any statistical relationship between the rainfalls received during these two monsoons over Tamil Nadu.

2.0 Methodology:

The spearman rank correlation coefficient is a Pearson correlation calculated from ranks replacing scores. We present the Spearman Rank-order correlation coefficients computed between the southwest and the northeast monsoon rainfall. This method (Press et al. 1992) of finding the correlation between two variabilities is more robust than the usual method (i.e., by linear correlation). The spearman method first determines the rank order of the sample values of each of the two variables X and Y separately. Then,

it transforms the original N ordered pairs of scores to N ordered pairs of ranks. The ranks of the X scores comprise all integers from 1 to N, and similarly for the Y scores. This procedure makes it possible to derive a simple computational formula based on a sum of squared differences between ranks

$$\rho = 1 - \frac{6 \sum D^2}{N(N^2 - 1)}$$

Where $D = R_x - R_y$, the difference between ranks corresponding to X and Y.

2.1 Data:

For the study 110 years (1901-2010) data of the southwest and northeast monsoon rainfall over Tamil Nadu is considered. The above data is obtained from the Regional Meteorological Centre, Chennai.

3.0 Results:

A graph of the two monsoon rainfall series (fig.1) suggests a tendency for an excess or deficit of the southwest monsoon rainfall to be associated with the opposite tendency in the northeast monsoon rainfall (Dhar et al., 1983). The graph is plotted taking the year along the x axis and the southwest and northeast rainfall in mm taken along the y axis for comparison.

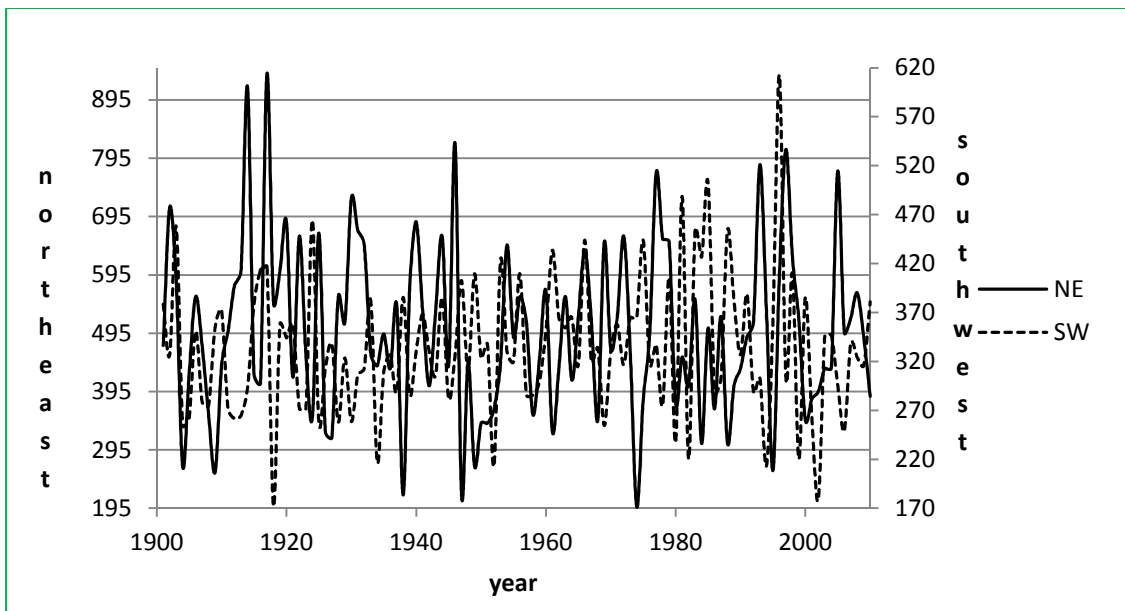


Fig 1: Shows the relationship between northeast and southwest monsoon rainfall

Table 1: Frequency of above normal, normal and below normal rainfall of the southwest and northeast monsoons over Tamil Nadu

Southwest monsoon	Northeast monsoon			Total
	Above normal	Normal	Below normal	
Above normal	15	-	29	44
Normal	1	-		1
Below normal	34	2	29	65
Total	50	2	58	110

From the above table

- In 29 years, the southwest monsoon was below normal and northeast monsoon was above normal;
- In 34 years, the southwest monsoon was above normal and northeast monsoon was below normal;
- In 2 years, the southwest monsoon was below normal and northeast monsoon was normal;

The inter-relationship between the two time series was investigated statistically with a correlation analysis and the results are shown in table 2.

Table 2: Cycle-to-cycle variation of correlation coefficients for the southwest and northeast monsoon rainfall respectively

Year	Length	Correlation Coefficient
1901-1911	11	-0.0361
1912-1922	11	-0.0977
1923-1933	11	-0.5375
1934-1944	11	-0.1095
1945-1955	11	-0.2454
1956-1966	11	0.0188
1967-1977	11	-0.5454
1978-1988	11	-0.0161
1989-1999	11	-0.1113
2000-2010	11	-0.3022

This indicates that, the southwest monsoon rainfall is negatively and significantly correlated with that of the northeast monsoon rainfall (Dhar et al., 1982). The meteorological factors responsible for this negative correlation are the subjects of another investigation which is being

pursued. However, from the above analysis, it may be inferred that a strong southwest monsoon over Tamil Nadu with rainfall above the normal is likely to induce weak northeast monsoon conditions with consequent below normal rainfall. The association between the northeast monsoon of the current year and the southwest monsoon of the following year was also investigated. The correlation coefficient between those two rainfall series was found to be 0.02 and this indicates that, the northeast monsoon rainfall has no relationship with the following southwest monsoon rainfall over the region.

4. Conclusion:

A study of the relationship of the southwest and the northeast monsoon season rainfalls over Tamil Nadu has suggested a tendency for an excess or deficit southwest monsoon rainfall to be associated with the opposite tendency in the subsequent northeast monsoon rainfall. Correlation analysis, which revealed a negative correlation, showed that

- The rainfall distribution during the southwest and the northeast monsoons are not independent.
- The magnitude of the deviation in the southwest monsoon is directly related to the magnitude of the opposite deviation in the northeast monsoon rainfall.

From the foregoing, it thus appears that, the observed southwest monsoon rainfall over Tamil Nadu can be used to provide a forecast of the behavior of the following northeast monsoon season.

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