

Trends and variability in northeast monsoon rainfall over Kerala

K.N. KRISHNAKUMAR and G.S.L.H.V. PRASADA RAO

Dept. of Agricultural Meteorology, College of Horticulture,
Kerala Agricultural University, Vellanikkara, Thrissur-680 656, Kerala
Email : kauagmet@yahoo.com

ABSTRACT

Monthly rainfall over Kerala state showed an increasing tendency during October and November with a decrease in December. Such trend was more evident since 1961 onwards. Overall, over Kerala State, there was an increase of 96.7 mm in northeast monsoon rainfall over a period of time, indicating an increase of 20.1 per cent against the normal rainfall of 481.5 mm and significant at 5 per cent level. Rainfall during December was highly variable and undependable, which is of great concern in plantation crop production of the State of Kerala. As a whole, 34.0 per cent (46 years out of 135) of the years recorded either excess or deficit rainfall. The monthly rainfall range as well as its variability was less during excess rainfall years when compared to that of deficit rainfall years. The study also revealed that El Nino/La Nina events had weak teleconnection with excess/deficit northeast monsoon rainfall over Kerala.

key words: Northeast monsoon, trends, coefficient of variation

The northeast monsoon accounts for 11 per cent of the annual rainfall over India and for about 17 per cent over the Kerala State. It decides the output of plantation crop production to a greater extent. Rainfall during northeast monsoon is closely associated with the westward passage of storms and depressions, which are remnants of low pressure systems that move into the Bay of Bengal (Das, 1995). The tapering shape of the peninsula and the lower elevation of westernghats in the south are the main reasons for rainfall over south Kerala. While the Indian summer monsoon, its variability and teleconnections have been extensively studied, relatively less attention has so far been given to the inter-annual variability of the northeast monsoon. Keeping the above in view, an attempt was made to study rainfall variability over Kerala during northeast monsoon period.

MATERIALS AND METHODS

The source of monthly rainfall (mm) over Kerala from 1871 to 1994 is from the IITM publication entitled "Monthly and seasonal rainfall series for all-India homogeneous regions and meteorological subdivisions: 1871-1994" (Parthasarathy *et al.*, 1995). From 1995 to 2002, the values were downloaded from the IITM website. From 2003 to 2005, the rainfall data were collected from the daily weather reports published by

the IMD, Trivandrum.

Time series analysis such as frequency distribution, moving averages, standard deviation and coefficient of variation were worked out for the above periods. The percentage contribution of rainfall through different months within monsoon was also worked out. The statistical significance of trends in monthly and season-wise rainfall series were examined by Mann-Kendall Test Statistics (Libiseller, C. and Grimall, A. 2002). The monthly and season-wise trends were also computed through a trend line. Rainfall of different months at 75 per cent probability was also worked out using the percentile rank method (Sakamoto *et al.*, 1984). The source of El Nino and La Nina data during 1871 - 2001 is from the publication "Climatic change and India-Issues, concerns and opportunities" (Kumar *et al.*, 2002).

RESULTS AND DISCUSSION

Monthly rainfall during northeast monsoon

The monthly rainfall of October during northeast monsoon was 288.1 ± 108.2 mm, contributing 59.8 per cent of seasonal rainfall; it is likely to be 204.5 mm in three out of four years. The highest rainfall (595.0 mm) was received in 1999, followed by 569.8 mm in

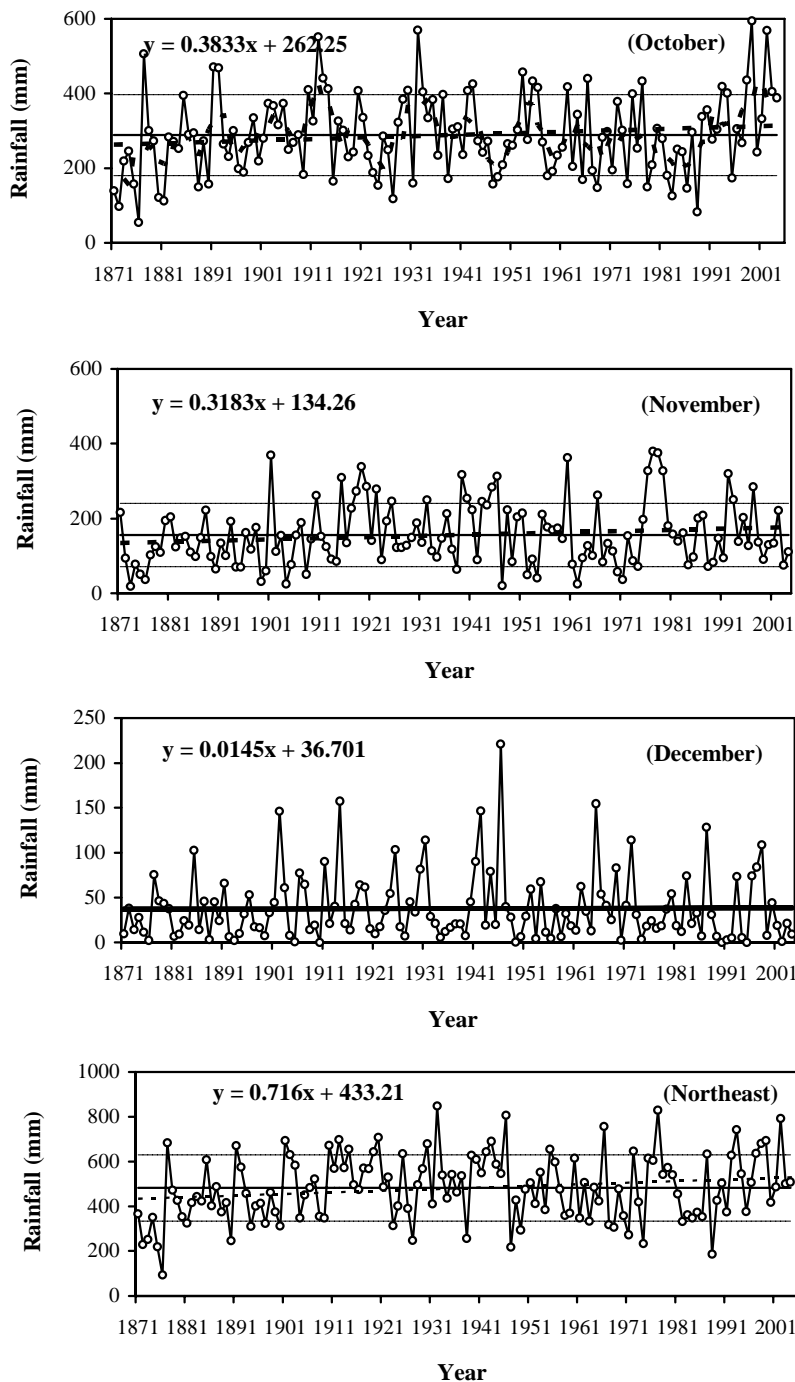


Fig.1: Rainfall (mm) during October, November, December and Northeast monsoon over Kerala from 1871 to 2005

1932. The lowest rainfall was received in 1876 (54.7 mm) with 82.3 mm in 1988. The inter-annual variability was relatively high during 1871 to 1900 (Coefficient of Variation (CV) -43.6 %) when compared to that of

1901-1930 (CV-31.8%), 1931-1960 (CV-34.8%) and 1961-2005 (CV-39.5%). Rainfall during October had an increasing trend and an increase of 51.7 mm of rainfall was noticed over a period of time (Fig.1). It

Table 1: Northeast monsoon rainfall (mm) during 1871-2005

Month	Rainfall variables	Sub-Periods				
		1871-1900	1901-1930	1931-1960	1961-2005	1871-2005
October	Normal Rainfall (mm)	251.0	306.3	298.4	293.1	288.1
	Standard Deviation	109.5	97.3	103.9	113.5	108.2
	Coefficient of Variation (%)	43.6	31.8	34.8	38.7	37.5
	75 % probability	157.1	242.7	234.1	204.5	204.5
	Mann-Kendall test statistics	1.3738	-0.9813	-0.8923	1.6043	1.4457
	Percentage contribution	63.4	58.2	58.0	60.1	59.8
November	Normal Rainfall (mm)	117.1	174.0	175.5	157.6	155.7
	Standard Deviation	56.0	87.3	88.1	89.9	84.7
	Coefficient of Variation (%)	47.9	50.1	50.2	57.0	54.4
	75 % probability	70.2	122.8	96.6	91.0	91.5
	Mann-Kendall test statistics	0.1071	0.7315	-0.3389	1.3598	1.5351
	Percentage contribution	29.6	33.1	34.1	32.3	32.4
December	Normal Rainfall (mm)	28.1	45.5	40.4	37.0	37.7
	Standard Deviation	23.9	40.0	48.6	37.0	38.5
	Coefficient of Variation (%)	85.2	87.9	120.3	100.1	102.1
	75 % probability	9.5	15.2	11.5	9.0	11.3
	Mann-Kendall test statistics	-0.2141	-0.0357	-0.7315	-1.3207	-0.2891
	Percentage contribution	7.0	8.7	7.9	7.6	7.8
Oct.-Dec.	Normal Rainfall (mm)	396.1	525.9	514.3	487.7	481.5
	Standard Deviation	129.7	126.6	146.2	152.4	147.8
	Coefficient of Variation (%)	32.7	24.1	28.4	31.2	30.7
	75 % probability	323.3	449.9	411.0	361.6	365.4
	Mann-Kendall test statistics	0.8028	-0.5531	-0.5174	2.0934*	2.0772*

was more evident since 1961 onwards. Such phenomenon was also noticed before the year 1900.

The monthly rainfall of November during northeast monsoon was 155.7 ± 84.7 mm, contributing 32.4 per cent of seasonal rainfall. The monthly rainfall in three out of four years is likely to be 91.5 mm. The highest rainfall (379.8 mm) was received in 1977, followed by 1978 (375.5 mm) and 1901 (369.0 mm). The lowest rainfall was received in 1873 (19.0 mm), followed by 1947 (20.3 mm), 1904 (25.0 mm) and 1879 (32.0 mm). The inter-annual variability was relatively high (CV-50.2%) during 1931-1960 when compared to that of 1901-1930 (CV-50.1%), 1961-2005 (CV-49.6%) and 1871-1900 (CV-47.9%). As a whole, the rainfall trend in November was increasing over a period of time (42.9mm). However, the increase in rainfall was less pronounced in November when compared to that of October.

The monthly rainfall of December during monsoon was 37.7 ± 38.5 mm, contributing 7.8 per cent of seasonal rainfall. The monthly rainfall in three out of four years is likely to be 9.9 mm. The highest rainfall (221.1 mm) was received in 1946, followed by 1914 (157.4 mm). The lowest rainfall (0.1 mm to 1.0 mm) was received in 1905, 1949, 1990 and 2002. The monthly rainfall during December showed a decreasing trend (-0.2891).

It revealed that the monthly rainfall during October and November was in increasing trend while decreasing in December. Such phenomenon was more evident since 1961 onwards. Rainfall during December was highly variable and undependable followed by November.

Seasonal rainfall during northeast monsoon

The normal rainfall during northeast monsoon season over Kerala from 1871 to 2005 is 481.5 ± 147.8

Table 2: El Nino / La Nina association with Northeast monsoon rainfall over Kerala during 1871-2005

No of years with	Deficit monsoon	Normal monsoon	Excess monsoon	Total
El Nino	4	15	8	27
La Nina	2	13	3	18
Other	15	61	14	90
Total	21	89	25	135

mm which constitutes about 17 per cent of annual rainfall. It is relatively undependable and the inter-annual rainfall variability is high (CV – 30.7 %) when compared to that of southwest monsoon. The dependable rainfall during northeast monsoon at 75 per cent level was 365.1 mm (Table 1). Though the variation in inter-annual rainfall during northeast monsoon is significant, it was always within \pm one standard deviation from the normal rainfall. A positive value of Mann-Kendall test statistic (2.0772) indicated that rainfall during northeast monsoon season had an increasing tendency which was significant at 5 per cent level. The trend line indicated an increase of 96.7 mm during the study period of 135 years.

Out of 135 years, 25 years recorded excess rainfall when compared to that of normal. Seasonal rainfall during excess rainfall years varied between 631.0 mm and 848.0 mm. Out of 135 years, 21 years recorded deficit rainfall when compared to the normal. The seasonal rainfall during deficit years varied between 93.3 mm and 334.8 mm. The occurrence of excess and deficit rainfall when compared to that of normal was seen in more or less equal number of years. As a whole, 34.0 per cent (46 years out of 135) of the years recorded either excess or deficit rainfall. Interestingly, the rainfall range and its variability was less during excess rainfall years when compared to that of deficit rainfall years.

El Nina/La Nina association with northeast monsoon rainfall

During 1871-2005, there were 27 El Nino and 18 La Nina episodes (Table 2). There were 21 deficit rainfall years during 1871-2005, but only 4 years belonged to El Nino years. There were 15 cases of normal monsoon years when El Nino occurred. Only 3

out of 25 excess rainfall were La Nina years. There were 13 cases of normal northeast monsoon years when La Nina occurred. The examination of El Nino/La Nina and northeast monsoon rainfall relationship over Kerala suggested that majority of the El Nino or La Nina events were associated with the normal monsoon years. Thus El Nino/La Nina events seem to have weak teleconnection with excess/deficit rainfall during northeast monsoon season over Kerala.

REFERENCES

- Das, P. K. (1995). The monsoons National Book Trust N. Delhi. 88.
- Kumar, K.R., Kumar, K.K., Ashrit, R.G., Patwardhan, S.K and Pant, G.B. (2002). Climate change in India: Observation and model projections. Climatic change and India-Issues, concerns and opportunities (eds. Shukla, P.R., Sharma, K.S and Ramana, P.V.). Tata McGraw-Hill Publishing Company Limited, New Delhi, PP.24-75.
- Libiseller, C. and Grimall, A. 2002. Performance of partial Man-kendall Test for trend detection in the presence of covariates. *Environmetrics*, 13:71-84.
- Parthasarathy, B., Munot, AA and Kothawale, D.R. (1995). Monthly and seasonal rainfall series for all India homogeneous regions and meteorological sub-divisions:1871-1994. Contributions from IITM, Pune, India. Research Report No. RR-065. p 113.
- Sakamoto, C., Achutuni, R and Steyaert, L. (1984). Development of Agroclimatic/crop condition index assessment models. Prepared by NOAA/NESDIS/ASSC in co-operation with Atmospheric Science Department, University of Missouri.