

## An Investigation of Heaviest Rainfalls over Coastal Andhra Pradesh of India during October

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### ABSTRACT

An investigation of the dates of occurrence of heaviest rainfall is very important for flood forecasting. We have considered this aspect in the present study by examining the daily rainfall data for four coastal stations Kakinada, Masulipatnam, Nellore and Visakhapatnam for the month of October for a 10-year period 1973–82. The data have been analyzed by considering the heaviest rainfalls for each station separately. We have defined the heaviest rainfall as that which exceeds two or more times the mean rainfall of the month. The study shows that heaviest rainfalls occur during the period 16–23 October. This feature is repeated year after year, constituting a rainfall singularity for the region.

### 1. Introduction

An important aspect of water resources planning is floods. These are caused by heavy and incessant spells of rains either in the upper reaches or at the outlet of the rivers and often result in damage to crops and property, loss of revenue, possible effects on the health of the population, and loss of lives. Warnings of heavy rainfall given sufficiently in advance would make it possible to take necessary precautions.

Occurrence of heaviest rainfalls on specified calendar dates and their repetition are characterized as singularities. Singularities are of great importance in the understanding of the physical processes in the atmosphere and they are useful in the long-range forecasting of the weather. Also, the study of singularities in rainfall could explain the mechanisms of rain development in clouds and hence help in planning agricultural operations. Some investigators (Dhar, 1954; Srirama Rao and Lokanadham, 1964; Reddy and Ramana Murty, 1976) have examined the occurrence of singularities in regional rainfall in India and their association with terrestrial and extraterrestrial phenomena.

Coastal Andhra Pradesh of India is significantly affected by the heaviest rainfalls and floods during mid-October. We have investigated this aspect in the present study by examining the daily rainfall data for four coastal stations during the month of October over a 10-year period.

### 2. Data

The heaviest rainfall values of four coastal stations of Andhra Pradesh, India for the month of October for the 10-year period 1973–82 have been used in the study. For this purpose, the heaviest falls are considered

as those which exceed two or more times the mean rainfall of the month. The data were extracted from the daily weather reports published by the India Meteorological Department. The details of the stations are given in Table 1.

### 3. Analysis

The daily total values of the heaviest rainfall were smoothed using three-day moving averages. The reality and repetition of the occurrence of heaviest rainfalls on or around fixed calendar dates year after year have been tested by splitting the rainfall data into two parts, one consisting of odd years and the other of even years.

### 4. Results

#### a. Simple three-day moving average

The values obtained are presented in Fig. 1a. The heaviest rainfalls occur during the periods 1–3, 16–23 and 27–30 October with peaks on 2, 17 and 28 of which 17 October is the most prominent. This feature is repeated year after year. The value of the peak of 17 October exceeded the mean value for the month by 3 times. The peak is significant at 0.1% level according to Student's-t test. It is further noticed that the total rainfall curve oscillates around a 15-day period which appears to be inherent in rainfall itself.

#### b. Method of bifurcation

The values obtained for even and odd years are presented in Figs. 1b and 1c, respectively. The features noticed in both cases are similar in many aspects and resemble those mentioned in section 4a. The finding suggests that the peak on 17 October is real. The curves

TABLE 1. Latitude, longitude and altitude of each of the stations from which daily rainfall data for the month October of the 10-year period, 1973-82, were used for the study.

Station	Lat (N)		Long (E)		Altitude above mean sea level (m)
	(deg)	(min)	(deg)	(min)	
Kakinada	16	57	82	14	08
Masulipatnam	16	11	81	08	03
Nellore	14	27	79	59	20
Visakhapatnam	17	41	83	18	04

in Figs. 1b and 1c have a cross-correlation coefficient of +0.52 significant at 0.01% level. While determining the significance of the correlation between the series, the autocorrelations have been taken into consideration for calculating the effective sample size (Mitchell et al. 1966). The Mann-Whitney test (Siegel, 1956) which is nonparametric, when applied to the distribution of the values of the two rainfall series have shown that the departure between the series is significant at less than 5% level. Also, the percentage increases indicated, on the mean, for the peaks noticed on 17 October in the two series (even and odd years) are significant at 0.1% level according to Student *t* test (Panofsky and Brier, 1958). This feature lends further support to the reality and repetition of the above peak.

## 5. Discussion and conclusions

The results of the present study show the occurrence of heaviest rainfalls during the period 16-23 October, with the prominent peak on 17 October constituting a rainfall singularity for the region. Bowen (1953) noticed that heaviest rainfalls occur on fixed calendar dates throughout the world and repeat year after year. He postulated a meteor shower hypothesis to explain such singularities in rainfall. But, divergent views have been reported on the acceptability of the meteor shower hypothesis. In an earlier study, Reddy and Ramana Murty (1976) observed singularities on or around 18 October and 20 November in the northeast monsoon (October-December) rainfall of Tamil Nadu for the period 1961-70. The observed singularities could not be explained on the basis of Bowen's meteor hypothesis. Martyn (1954) pointed out that these singularities might be due to the influence of cyclones. Maybank and Qureshi (1966) suggested that the singularities are due to the day-to-day inhomogeneity in the long-term average pressure pattern. Reddy and Ramana Murty (1981) have shown that the observed singularities in rainfall of Tamil Nadu are associated with neither cyclonic disturbances of the Bay of Bengal nor day-to-day sea level pressure variations.

Rao et al. (1970) pointed out that over coastal An-

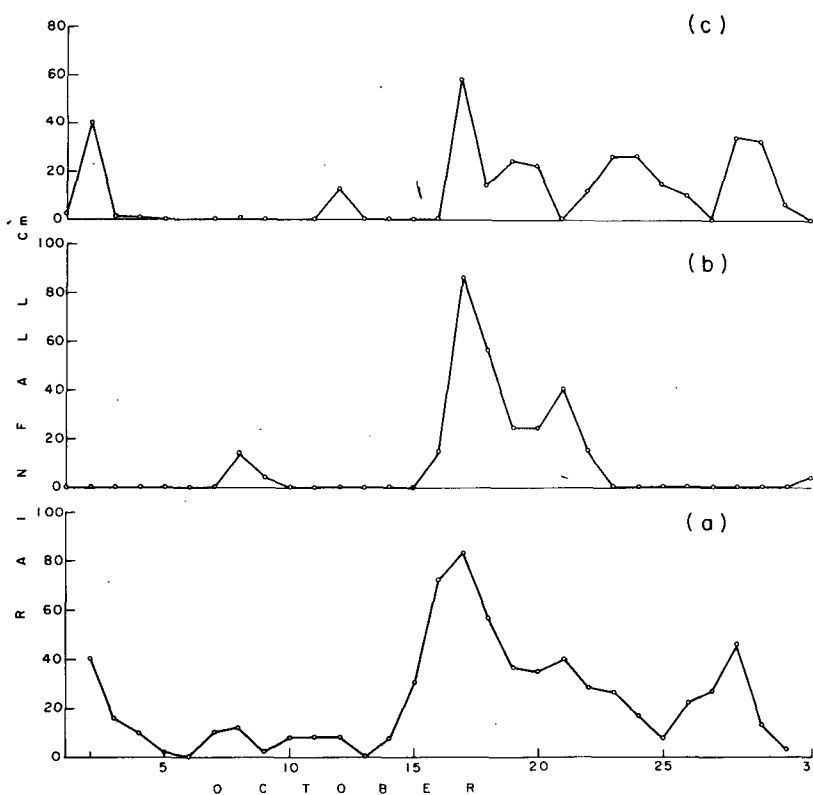


FIG. 1. Plots of total rainfall versus dates for the month October for the 10 year period 1973-82: (a) simple three-day moving averages of rainfall, (b) bifurcation of data for even years, (c) bifurcation of data for odd years.

dhra Pradesh heavy spells of rain, particularly in the pre- and post-southwest monsoon period, generally occur in association with the movement of Bay Depressions/Cyclonic Storms. The observed heaviest rainfalls of the present study and their association with cyclonic disturbances of the Bay of Bengal require further investigation. The mean position of the equatorial trough, a region of rising air currents and convective clouds, is located around Andhra Coast during October (Chen and Lim, 1978). Convergence along the equatorial trough is a maximum in the region of easterly waves where the clouds are thickest and the rain is more frequent and more intense (Longley, 1970). Reddy et al. (1984) have made a preliminary examination of the low-level winds between 0.3 km and 3.0 km observed at Madras (located near Andhra Coast) during the month October for the period 1961–70. They observed that normally the low-level winds are northwesterlies, northeasterlies, easterlies and south-easterlies. The heaviest rainfalls are mostly associated with an increase in easterlies on or around the dates of the singularities. Reddy and Ramana Murty (1976) pointed out that the 15-day periodicity in the rainfall of Tamil Nadu during the northeast monsoon may be responsible for the observed singularities in rainfall. The present study also indicates a 15-day periodicity.

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