Monsoon rainfall and its variability in Godavari river basin

G NAGESWARA RAO
Atmospheric Science Centre, Department of Meteorology and Oceanography, Andhra University,
Visakhapatnam 530 003, India

Rainfall variability over a river basin has greater impact on the water resource in that basin. With this in view, the variability of the monsoon rainfall over the Godavari river basin has been studied on different time scales. As expected, the monsoon rainfall in Godavari basin is more variable (17%) than the all-India monsoon rainfall (11%) during the period of study (1951–90). Similarly, inter-annual variability of the monsoon rainfall on smaller time scales is found to be still higher and increases while going on from seasonal to daily scales. An interesting observation is that the intra-seasonal variability of the monsoon rainfall has a significant negative relationship (CC = -0.53) with the total seasonal rainfall in the basin.

1. Introduction

The water resource in almost all the major rivers in India is largely affected by the vagaries of monsoon, resulting in floods during some periods and droughts during some other periods. There have been a large number of studies on the Indian monsoon rainfall variability (Shukla 1987; Mooley and Shukla 1987; Hastenrath 1991 for reviews). All these studies are based on the seasonal rainfall data from the whole country or from the meteorological sub-divisions and some are based on the rainfall data from individual stations only. However, study of the same over a river basin, which has greater impact on its water resource and on smaller time scales, is even more important. In the present paper, the author studied the variability of the monsoon rainfall in the Godavari river basin on seasonal and monthly scales during 1951–90 and on decadal (10-days) and daily scales during 1963–84.

The Godavari basin with a catchment area of about 3,12,800 sq.km., lies in central India to the south of the mean monsoon trough and receives about 85% of its annual rainfall during the monsoon season. The Godavari basin is occupied over 30 districts of 5 states in central India (figure 1). The catchment area of the basin is bounded on the west by the Western Ghats, on the east by the Eastern Ghats and on the north by the Satmala hills. These hill ranges play an important role in the distribution of the seasonal rainfall in the basin (figure 2). The seasonal rainfall is very high over the hilly regions of the extreme west and in the north and east. Immediately after crossing the Western Ghats, the rainfall decreases rapidly and then starts increasing gradually towards the east. The north-eastern parts of the basin also receives heavy rainfall due to the passage of monsoon disturbances from the Bay of Bengal in a northwesterly direction across and to the north of the basin.

2. Data

Monthly (June to September) rainfall for 40 years (1951–90) and daily (1st June to 30th September) rainfall for 22 years (1963–84) of about 4 to 10 stations in each of the 30 districts of the basin has been collected from the India Meteorological Department. The areal average rainfall of the entire basin is evaluated from the area-weighted average rainfall of these 30 districts. In a similar manner, Mooley and Parthasarathy (1984) evaluated the monsoon rainfall over the plains of India during 1871–1978 by using one station in each of the 306 districts in India. The monthly rainfall during 1951–90 and the daily rainfall during 1963–84 of the Godavari basin, evaluated as
Figure 1. Location map of the Godavari river basin with raingauge stations considered and the districts boundaries. Major hill ranges around the basin are also shown: (1) Nasik; (2) Ahmednagar; (3) Aurangabad; (4) Bhir; (5) Buldana; (6) Parbhani; (7) Osmanabad; (8) Nanded; (9) Akola; (10) Yeotmal; (11) Amraoti; (12) Wardha; (13) Nagpur; (14) Biandara; (15) Chandrapur; (16) Adilabad; (17) Nizamabad; (18) Medak; (19) Karimnagar; (20) Warangal; (21) Khammam; (22) West Godavari; (23) East Godavari; (24) Visakhapatnam; (25) Koraput; (26) Bastar; (27) Balanagar; (28) Seoni; (29) Chhindwara; (30) Bidar.

Figure 2. Distribution of mean monsoon rainfall (in cm) over the Godavari basin during 1901–50.

above have been used to study the monsoon rainfall variability on different time scales.

To study the inter-annual variability, rainfall statistics like the mean, standard deviation, coefficient of variation (CV), the highest and the lowest values and their percentage departures from the mean have been evaluated on seasonal, monthly, decadal and daily scales. These statistics are also useful for the Water Resource Management in the basin.

3. Results

3.1 Inter-Annual Variability (IAV)

Statistics regarding the IAV of the seasonal rainfall are given in table 1. The mean seasonal rainfall in Godavari basin during 1951–90 is evaluated to be 92.3 cm, which has its lowest value (64.3 cm) in 1974 and the highest value (122.1 cm) in 1959. The seasonal rainfall in Godavari has a variability of 17%, while the variability of the all-India monsoon rainfall during the same period is found to be only 11%. Thus, the monsoon rainfall in Godavari basin is more variable than the all-India monsoon rainfall, as expected.

The normalized anomalies of the seasonal rainfall in Godavari during 1951–90 are shown in figure 3. They varied from −1.8 in 1974 to +1.9 in 1959. By considering the years with the rainfall anomaly less than −1.0 as deficient rainfall years and the years with the anomaly more than +1.0 as the excess