The Prediction of Indian Monsoon Rainfall: A Regression Approach

Goutami Bandyopadhyay goutami15@yahoo.co.in

1/19 Dover Place
Kolkata-700 019
West Bengal
India

Abstract

The present paper analyses the monthly rainfall data of the Indian summer monsoon months between 1871-1999. Multiple linear regression is used to predict the average summer-monsoon rainfall using the previous years' data from the corresponding time period.

Keywords: summer-monsoon, India, rainfall, prediction, multiple linear regression

1. Introduction

India is basically an agricultural country and the success or failure of the harvest and water scarcity in any year is always considered with the greatest concern. These problems are closely linked with the behavior of the summer monsoon rains in India (Rajeevan, 2001). The term *monsoon* seems to have been derived either from the Arabic *mausin* or from the Malayan *monsin*. As first used it was applied to southern Asia and the adjacent waters, where it referred to the seasonal surface air streams which reverse their directions between winter and summer, southwest in summer and northeast in winter in this area. During the summer the continent is heated, leading to rising motion and lower pressure. This induces airflow from sea to land at low elevations.

Eastern and southern Asia has the earth's largest and best developed monsoon circulations. The tropical monsoon circulation of southern Asia, including India-Pakistan and Southeast Asia, differs significantly from East Asia monsoon. The Indian monsoon is effectively separated from that of China by the Himalayan-Tibet system. In summer a deep and widespread surface pressure trough extends across northern India-Pakistan into Southeast Asia. This is part of the planetary intertropical convergence zone, which here reaches its maximum poleward displacement. To the south of the trough is a deep current of maritime tropical air called the southwest monsoon. This current appears to originate in the southeast trades of the Indian Ocean east of Africa. As this stream of air approaches and crosses the equator its direction becomes southerly and then southwesterly. Along the Somali coast of Africa the flow becomes especially strong, taking the form of a low-level jet. In crossing the Arabian Sea the southwesterly current gains considerable moisture and becomes less stable. This unstable southwesterly current crosses India, continues eastward over the Indochina peninsula, and then moves northward over much of eastern Asia. It is a great moisture source for most of southern Asia.

2. Indian monsoon rainfall- brief literature review

Guhathakurta (2006) implemented an Artificial Neural Network method in predicting monsoon-rainfall over Kerala, a southern state of India. This paper proved that a neural net approach could be applicable to predict rainfall over districts of Kerala up to 2003. But, a major drawback of this paper is that it did not analyze the autocorrelation structure of the rainfall time series and chose the input matrix quite arbitrarily. Gadgil et al. (2002) discussed various aspects of summer monsoon rainfall prediction. Rejeevan (2001)

discussed various problems associated with prediction of Indian summer monsoon rainfall. Gadgil et al. (2005) discussed the reasons behind failure in prediction of Indian summer monsoon rainfall. Hasternrath (1988) discussed the usefulness of regression model in predicting Indian summer monsoon rainfall.

3. Data and analysis

Data used in the present study are collected from the website http://www.tropmet.res.in published by Indian Institute of Tropical Meteorology. In this study only four months' data (June-August) are explored because these three months are the Indian summer monsoon months.

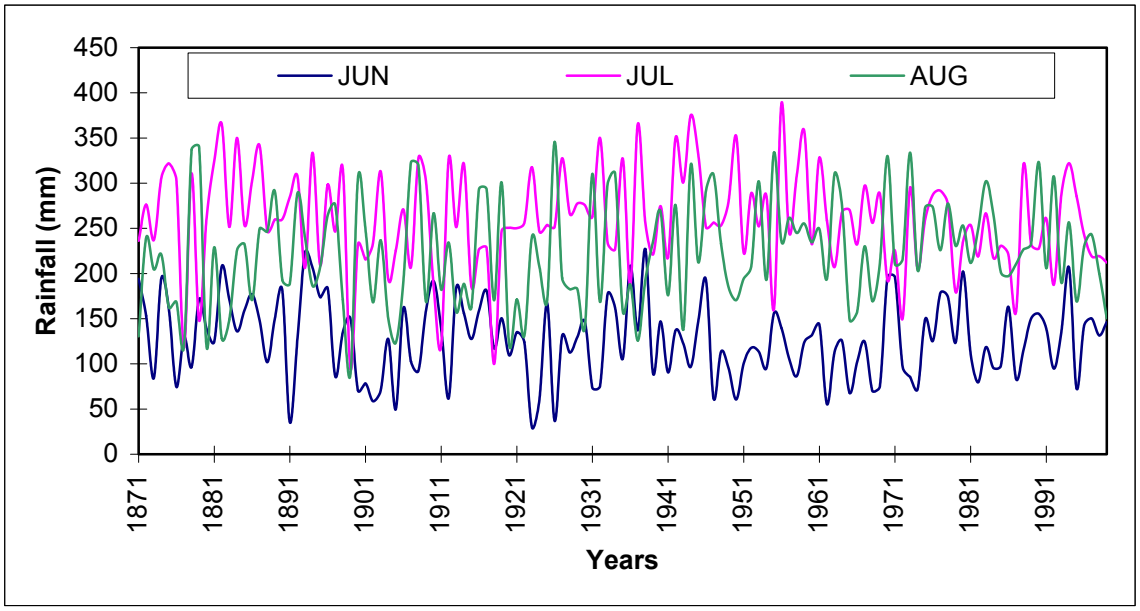

Fig.01- Monthly rainfall (mm) in the summer monsoon season over India during 1871-1999

The Pearson correlations between the data pertaining to different months are computed and are displayed in Table-01. The table shows that the months are not significantly correlated with respect to monthly rainfall of the summer monsoon season.

Months	Pearson correlation coefficients
Jun-Jul	-0.059362253
Jun-Aug	-0.013968157
Jul-Aug	-0.013968157

Table 01- Tabular presentation of the monthly rainfall amounts of different monsoon months

4. Multiple Linear Regression Model

In this research paper, a multiple linear regression (MLR) method is adopted to predict the average summer monsoon rainfall in a given year using the monthly rainfall data of the summer-monsoon of the previous year.

After computation, the MLR equation is set as

y=0.03x1+0.06x2+0.02x3+229

Where, x1= June rainfall of year Y

x2= July rainfall of year Y

x3= August rainfall of year Y

y= Average rainfall of year Y+1

[1]The actual and predicted average rainfalls are presented in Fig.02.

Readers wishing to see the detail of the derivation of the MLR equation are encouraged to contact the author directly.

[1] Paper submitted to *Solstice-An Electronic Journal of Geography and Mathematics*

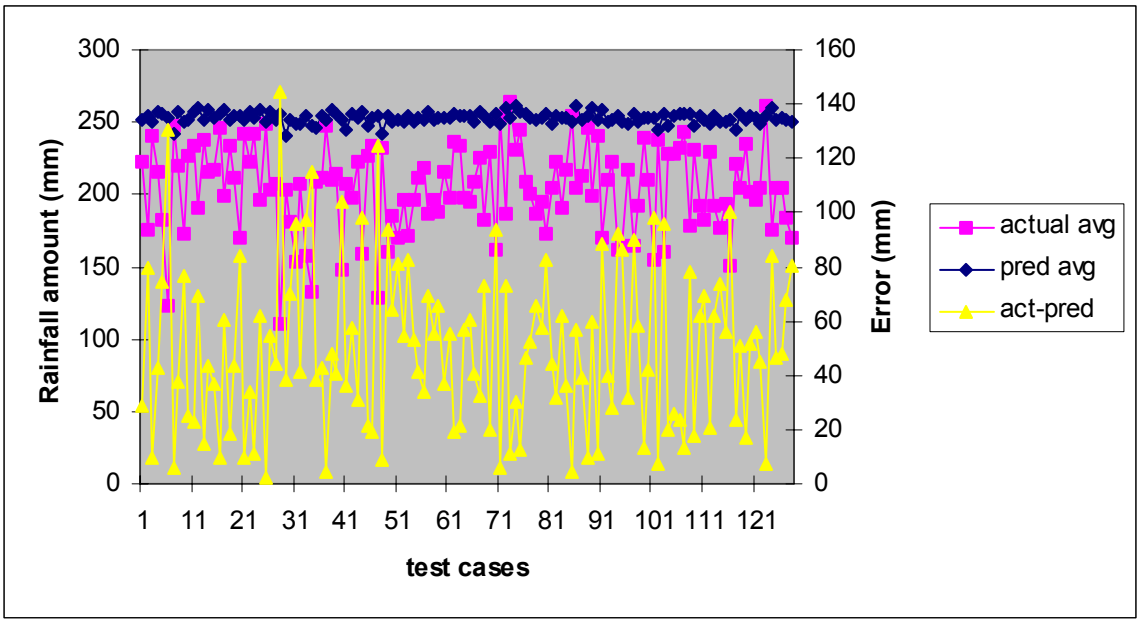

Fig.02- Schematic of the actual and predicted average monthly rainfall of Indian summer monsoon during 1872-1999

Overall prediction error is found to be 26.46%.

The t-statistics are computed from the MLR related components and are computed and tabular values are compared. The computed values are based upon the hypothesis that the input value is a good predictor of the predictand. The computed and critical tabular values are presented in Fig.03.

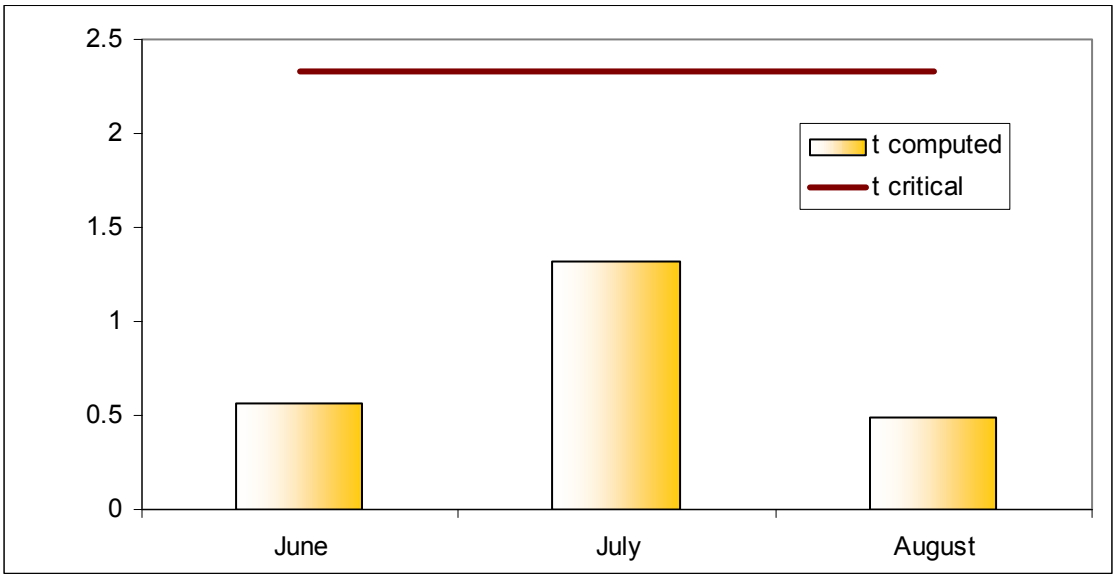

Fig.03- The computed and critical t-values

It is found that all the computed t-values fall below the tabular values of t. This illustrates, in the sample studied, that none of the months is a good predictor of average monsoon rainfall of a given year. The criticism (mentioned in section 2 above) of the neural net approach, that it did not analyze the autocorrelation structure of the rainfall time series, may be unfounded. The topic of monsoon-rainfall data series is highly complex; the role that multiple linear regression might play in this topic is one for future research—it appears, from the evidence here, not to be useful as a predictive model. Whether it might be useful for offering an approximate value of future monsoon rainfall remains to be seen.

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