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Estimation of monsoon rainfall using winter temperature and pressure data

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सार — प्रस्तुत शोध-पत्र में सह-संबंध तकनीक का प्रयोग करते हुए, ढाका पर मानसून वर्षा (जून से सितम्बर) के दीर्घ अवधि पूर्वानुमान की विधियों को विकसित करने का प्रयत्न किया गया है। उसी स्थान के मौसम वैज्ञानिक प्राचल अर्थात् सन 1961-77 की मानसून अवधि के दौरान वर्षा, फरवरी के सतही तापमान और समुद्र स्तर दाब, विशेष रूप से सह-संबंधित पाए गए हैं। इन प्राचलों का प्रयोग करके, (क) जून से अगस्त तक की कुल वर्षा, (ख) सितम्बर के दौरान वर्षा, और (ग) कुल मानसून वर्षा (जून से सितम्बर तक) के आकलन के लिए पूर्वानुमान समीकरणों को विकसित किया गया है। व्युत्पन्न पूर्वानुमान समीकरणों की कुशलताओं का तीन वर्षों (1978-80) की अवधि के लिए परीक्षण किया गया और ये दो वर्षों में काफी अच्छे पाये गये हैं।

ABSTRACT. The present study is an attempt to develop methods for the long range prediction of monsoon rainfall (June to September) over Dhaka by using correlation technique. Meteorological parameters of the same station, namely, the surface temperature and sea level pressure of February are found to correlate significantly with the rainfall during the monsoon period, for the years 1961-77. Using these parameters prediction equations are developed for the estimation of (a) total rainfall of June to August, (b) rainfall during September and (c) total monsoon rainfall (*i.e.*, June to September). The skills of the derived prediction equations have been examined for a test period of 3 years (1978-80) and are found to be reasonably good in two years.

1. Introduction

Monsoon-borne rains support food production in Bangladesh and other countries of the sub-continent and southeast Asia as a whole. In Bangladesh about 75 to 80 per cent of the annual rainfall (Aziz 1983) occurs during monsoon season (June-September). Delay of monsoon or a deficient monsoon rainfall causes droughts resulting in a decrease in food production. On the other hand, excessive monsoon rainfall causes flood. Considering these, it is vital for the economy of Bangladesh to attempt an accurate long range monsoon rainfall forecast, at least about 3 months ahead of the season. This will provide sufficient time in planning, planting and harvesting of crops, selecting varieties of crops for the monsoon period.

Because of the large impact of monsoon rainfall on the economy of the countries under its direct influence, many efforts have been made by scientists at different periods to develop methods for its prediction. Sir Gilbert Walker pioneered studies in the long range forecasting of monsoon rainfall of India. He introduced correlation approach to seasonal forecasting. He developed a number of regression formulae for forecasting rainfall in India. Many other authors like Jagannathan and Bhalme (1973), Shukla and Misra (1977) carried out their research work in this field. They examined the correlation between rainfall of India and other parameters. Recently Thapliyal (1981) has made an attempt to develop the leading indicator model for forecasting the monsoon rainfall over the Peninsula. The long range rainfall forecast method of Bangladesh Meteorological Department is based firstly on a statistical model, where rainfall of preceding four months is taken into account (Aziz 1983). This is then supplemented by climatological data sets, synoptic charts (surface and upper air) of the previous month and satellite imageries (orbital and geo-stationary). The purpose of the present work is to develop a probable method for the long range prediction of monsoon rainfall over Dhaka (Bangladesh), a meteorological station with moderate rainfall.

2. Data and method

Two parameters, namely, winter surface temperature and winter sea level pressure of the same station, are chosen as the probable predictors. The correlation coefficients between temperature and rainfall & pressure and rainfall have been computed and statistically

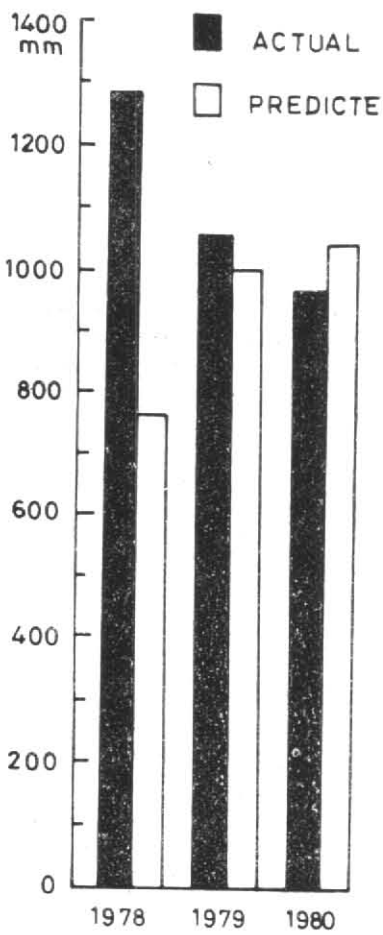

Fig. 1. Prediction of total rainfall from June to August

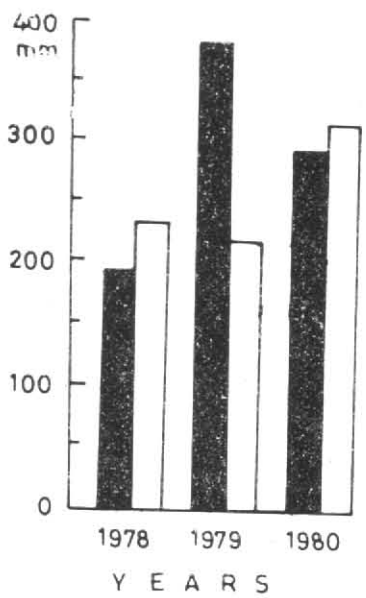

Fig. 2. Prediction of September rainfall

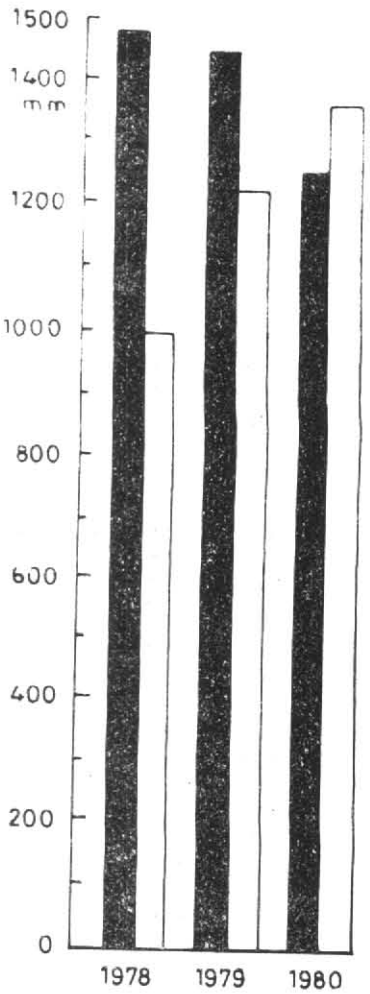

Fig. 3. Prediction of total monsoon rainfall (June to September)

TABLE 1

Period	Predictor	Correlation coefficient for the period 1961-77	Test of significance
September	Mean minimum temperature of February	+0.60	Significant at 5% level
June-August	Mean sea level pressure of February	—0.49	Significant at 5% level

significant relationships have been used for developing the prediction equations. Two cases where the relationships are statistically significant are shown in Table 1.

From the above table it can be seen that there is a significant correlation between mean minimum temperature of the last month of winter (*i.e.*, February) and rainfall of the monsoon withdrawal month (*i.e.*, September) and also there is a significant correlation between mean sea level pressure of the last month of winter (*i.e.*, February) and total rainfall of first three monsoon months (*i.e.*, rainfall for June to August). These relationships are used in developing the prediction equations for the estimation of rainfall during the monsoon period.

The data set used in developing the prediction equations consists of mean minimum temperature of February, mean sea level pressure of February, rainfall for the month September and total rainfall of June to August of Dhaka for 17 years period (1961-77).

3. Results

Three regression equations are developed for the prediction of total rainfall of June to August, rainfall for the month of September and total monsoon rainfall (total rainfall of June to September) over Dhaka. Since none of the temperature and pressure values individually by themselves has shown statistically significant correlation with total monsoon rainfall, an indirect combination method is applied for the prediction of total monsoon rainfall. In this method, the derived prediction equation for total rainfall from June to August is added with the prediction equation for September rainfall. The prediction equations that have been developed from this study are given below :

(i) *Prediction equation for total rainfall of June to August*

$$Y_{JA}=117448.2-114.906\,X_P \text{ (Feb)} \quad (1)$$

where Y_{JA}=predicted total rainfall of June to August over Dhaka in mm for a year,

X_P (Feb)=mean sea level pressure of February over Dhaka in mb for the same year.

(*ii*) *Prediction equation for September rainfall*

$$Y_{Sep}=-906.858+80.906\,X_T \text{ (Feb)} \quad (2)$$

where, Y_{Sep}=predicted rainfall of September over Dhaka in mm for a year,

X_T (Feb)=mean minimum February temperature (in °C of Dhaka for the same year.

Both the prediction Eqns. (1) & (2) are developed by using the method of least squares.

(*iii*) *Prediction equation for total monsoon rainfall (total rainfall of June to September)*

$$Y_{JS}=116541.35+80.906\,X_T\text{(Feb)}-114.906X_P\text{(Feb)} \quad (3)$$

where, Y_{JS}=predicted total monsoon rainfall over Dhaka in mm for a year ;

X_T (Feb) and X_P (Feb) (defined in the Eqns. 1 & 2 are taken for the same year.

3.1. *Performances of the equations derived*

The skills of the derived equations have been examined for the test period 1978-80 (data of temperature and pressure in the form as used in the prediction equations are of available after the year 1980). Bar diagrams of Fig. 1 show the performance of the prediction equation for total rainfall of June to August. Performance is good in 1979 and 1980 but in 1978 the predicted value is too low. Bar diagrams of Fig. 2 show the performance of the prediction equation for September rainfall. It is seen from the figure that the predicted values are close to the realized ones in 1978 and 1980. However, in 1979 the predicted value is too low. Fig. 3 shows the performance of the equation for total monsoon rainfall.

Here the differences between the actual rainfall values and predicted rainfall values are within tolerable limits during the year 1979 and 1980. But in 1978, the predicted value is too low.

4. Conclusions

Three regression equations are developed in this study for the prediction of rainfall over Dhaka during the monsoon period. During the three-year test period (1978-1980), the performance of different prediction equations have been found good on two years. As the predictors are selected from the winter season, using these equations one might be able to make an idea just after winter about the amount of rainfall over Dhaka during the monsoon period. This provides about 3 months lead time which appears to be sufficient for planning the agricultural operations, flood control etc. Before applying this method of prediction using winter data for operational purposes, its utility need to be examined for longer series of data over Dhaka and other meteorological stations of Bangladesh.

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