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CORRELATION OF MONTHLY TEMPERATURE AND RAINFALL BETWEEN THE CONSECUTIVE MONTHS OF THE MONSOON SEASON

BY

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Abstract :

In this paper an attempt has been made to investigate the correlation of some meteorological parameters of consecutive months of monsoon season i.e. June - July, July - August, August - September. The meteorological parameters are dry bulb temperature, wet bulb temperature, rainfall and maximum and minimum temperature. We have considered 29 stations all over Bangladesh under 6 divisions during the period 1951-2000. From the analysis we found that except for a few stations, the correlation coefficients for the wet bulb temperature and minimum temperature are positive. Those for dry bulb temperature of May and June are also positive.

Keyword : *meteorological parameter, correlation, bulb temperature, maximum and minimum temperature.*

¢hj§aÑ pjl *(Bengali version of the Abstract)*

HC f-œ -j±p¤¤j£ Ga¥l flfl c¤"¢V jj-pl -kje S¥e-S¥mjC, S¥mjC-BNø Hhw BNø--p-ÃVðl - Hl BhqNa fËQ-ml (Parameter) pq-f¢lhaÑe-L Ae¤påj-el -Qøj Llj q-u-Rz ö×L hjmÄ Eo·aj, ¢pš² hjmÄ Eo·aj, hª¢øfja, p-hÑjµQ Hhw phÑ¢ejÀ Eo·aj-L BhqNa fËQm ¢qpj-h dlj q-u-Rz 1951 - 2000 pj-ml j-dÉ pjNË hjwmj-c-nl 6¢V ¢hij-Nl 27¢V -ØVne-L ¢h-hQej Llj q-u-Rz ¢h-nÔoZ -b-L Bjlj -c-M¢R -k AÒf pwMÉL -ØVne hÉ¢a-l-L ¢pš² hjmÄ Eo·aj Hhw phÑ¢ejÀ Eo·ajl SeÉ pq-f¢lhaÑe pqN…¢m GZjaÈL qu Hhw -j-S¥e jj-pl SeÉJ Cqj ö×L hjmÄ Eo·ajl SeÉ GZjaÈL quz

1. Introduction :

Climate is the most important phenomenon for life on the earth. It is not constant but changing continuously. The climatic conditions of Bangladesh depend on south-west monsoon. Two seasons are well marked in Bangladesh, namely dry season and rainy season. In winter dry weather prevails. Rainy season begins from May and continues upto September. Rainy season is divided into 1) pre-monsoon (March to May), 2) monsoon (June to September) and 3) post monsoon (October to November) (Das, 1995). Monsoon season is most important for rainfall and pre-monsoon and post monsoon seasons are characterized by severe cyclone formation in the Bay of Bengal (Hussain and Sultana, 1996). The dry bulb temperature refers basically to the ambient air temperature which is indicated by a thermometer not affected by the moisture of tile air. The wet bulb temperature is the temperature of adiabatic saturation. In recent Studies it is found that dry bulb temperature (Ara et al., 2005), maximum and minimum temperature and rainfall (Karmakar et al., 2000) have increased over Bangladesh and sea level has also risen in the Bay of Bengal. Although the mean temperature falls hardly by one degree, the maximum temperature falls by 2-5°C over most part of the country except the coastal districts where the fall is by 5-6°C [WMO/UNDP/BGD/79/013,1986]. Chowdhury and Debsarma (1992) observed that the increasing tendency of the lowest minimum temperature over Bangladesh. Karmakar and Shrestha (2000) have studied the annual maximum and minimum temperature during the period 1961-1990 and found an overall increase in temperature by 0.5°C, which is comparable in magnitude to the global warming. Karmakar and Nessa (1997) have studied the continuously changing pattern of climate and its impacts on natural disasters and south-west monsoon over Bangladesh and the Bay of Bengal.

They found that the mean annual temperature over Bangladesh have shown increasing tendency especially after 1961-1970. Since monsoon season is most important for rainfall in and around Bangladesh, in the present study we tried to find out the correlation coefficient among different months of monsoon season by using the climatic parameters e.g. dry bulb temperature, wet bulb temperature, Maximum Temperature, Minimum Temperature and Rainfall of 29 metrological stations all over Bangladesh during the period 1951 to 2000, i.e., 50 years.

2. Materials and Methods :

Two variable linear correlation technique has been used in this study. The elementary principles of two-variable linear correlation

$$Y_c = a + bX$$

This permitted us to make estimates of the value of the dependent variable from values of the independent variable. Next it is demonstrated that the total variation of the dependent variable is the sum of the explained variation and the variation which we have failed to explain by our hypothesis; that is

$$\sum y^2 = \sum y_c^2 + \sum y_s^2$$

Here, $\sum y^2 = \sum Y^2 - \bar{Y}\sum Y$ and $\sum y_c^2 = \sum Y_c^2 - \bar{Y}\sum Y$. In which

$$\sum Y_c^2 = a\sum Y + b\sum XY$$

Or, more simply $\sum y_c^2 = b\sum xy.$

Then the ratio, $r^2 = \dfrac{\sum y_c^2}{\sum y^2}$ known as the coefficient of determination, and its square root is called the coefficient of correlation.

t-distribution (Kapur and Saxena) is used for the significance test-

$t_{cal} = \frac{r}{\sqrt{(1-r^2)/(n-2)}}$ where r is the correlation coefficient, n is the number of data and $(n\text{-}2)$ is the degree of freedom.

3. Results and Discussions :

The two variable linear correlation technique is carried out for several parameters. The results are discussed in detailed.

3.1 ***Correlation coefficients of dry bulb temperature between the consecutive months of monsoon season over different areas of Bangladesh***

May-June: We observed that, the correlation coefficient of average dry bulb temperature between May and June increases from Jessore region towards Sundarbon and from Dinajpur to northeast region. The results show that, at Rangpur, Ishwardi, Srimangal, Satkhira, Khulna, barisal, Khapupara, M.Court, Cox's Bazar and Sitakunda have positive correlation between May & June which is significant at 99% level (Fig1(a)).

June-July: The distribution of the correlation coefficients of average dry bulb temperature between June and July shows that the correlation increases from Rajshahi region towards Rangpur and from Ishwardy to south region. The maximum positive and negative correlation is observed at Rangpur and Feni respectively and the values are 0.8 and -0.2 respectively (Fig1(b)).

July-August: We observe that the correlation coefficient of dry bulb temperature between July and August increases from Feni towards northeast. Here we observed that, at Rangpur, Bogra, Srimangal, Mymensing, Satkhira and M.Court have high positive correlation between July & August which significant level is 99% (Fig1(c))..

August-September: The correlation coefficient of dry bulb temperature between August and September increases from Rajshahi towards Rangpur and Feni region to Cox's Bazar. From the analysis we can see at Rangpur,

Bogra, Satkhira, M.Court, Srimangal, Rangamatti, Chittagong and Teknaf and there is a high degree of positive correlation between August and September and from t-test we get significant level is 99%. (Fig1(d)).

3.2 *Correlation coefficient of wet bulb temperature between the consecutive months of monsoon season over different areas of Bangladesh*

May-June: The correlation coefficient of wet bulb temperature between May and June increases from Jessore towards Northwest and from Khepupara to Barisal . From the analysis we see that, at Rangpur, Dinajpur, Rajshahi, Sylhet, Faridpur, Barisal, Rangamati, Cox's Bazar and Teknaf have high positive correlation between May and June, which is significant at 99% level (Fig2(a)).

June-July: We have seen that the correlation coefficient of wet bulb temperature between June and July increases from Satkhira towards North-West and from M.Court to South-East. The high positive and negative correlation coefficient is observed at Dinagpur and Feni and the values are 0.9 and -0.13 respectively (Fig2(b)).

July-August: We have seen that the correlation coefficient of wet bulb temperature between July and August increases from Jessore towards Rangpur. From the observing data we see that, at Rangpur, Bogra, Rajshahi, Ishwardi, Srimangal, Mymensing, Dhaka, Faridpur, Jessore, Satkhira, Khulna, Barisal, Patuakhali, Khepupara, Chandpur, M.Court, Hatia, Sandwaip, Rangamati, Chittagong, and Teknaf, there is a high degree of positive correlation between July and August, which significant level is 99% (Fig2(c))

August-September: The correlation coefficient of wet bulb temperature between August and September is increases from Khulna towards Rajshahi and from Dhaka to North-West. From the observing data we see that, at

Rangpur, Bogra, Srimangal, Faridpur, Jessore, Satkhira, Khulna, Barisal, Patuakhali, Khepupara, Comilla, Feni, M.Court, Sandwaip, Rangamati, Madaripur, and Teknaf, have a high valus of positive correlation between August and September, which is significant at 99% level(Fig2(d)).

3.3 *Correlation coefficients of rainfall between the consecutive months of monsoon season over different areas of Bangladesh*

May-June: We observe that, the correlation coefficient of rainfall between May and June changes positively from Dinagpur towards Jessore and from Sundarbon to Hatiya. The maximum positive and negative value of the correlation coefficient is observed at Jessore and Madaripur region and the values are 0.5 and -0.18 respectively (Fig3(a)).

June-July: The correlation coefficient of rainfall between June and July positively changes from Sylhet towards Mymensing and Ishwardi to west region. .From the distribution pattern we observe that at Rajshahi, Sylhet, Dhaka, Barisal, Khepupara, M.Court, Feni, Sandwaip and Madripur region the correlation coefficient is negative. From the analysis we can say that there is negative correlation between June and July which is significant at 99% level (Fig3(b)).

July-August: The correlation coefficient of average rainfall between July and August positively changes from north side of the country at Rangpur towards Jessore, Khepupara to Feni and also increases from Chittagong to Teknaf. The maximum positive and negative value of the CC is observed at Jessore and Khepupara region and the values are 0.6 and -0.14 respectively (Fig3(c)).

August-September: The correlation coefficient of rainfall between August and September increases from Ishwardi region towards Jessore and from Cox's Bazar to Maizdy region. From the distribution pattern we observe that

at Bogra, Rajshahi,Sylhet ,Khepupara, M.Court, Sandwaip and Chittagong region the correlation coefficient is negative. The maximum positive and negative value of the correlation coefficient is observed at Hatiya and Khepupara region and the values are 0.6 and -0.33 respectively (Fig3(d)).

3.4 *Correlation coefficient of average maximum temperature between the consecutive months of monsoon season over different areas of Bangladesh*

May-June: We have seen that the correlation coefficient of average maximum temperature between May and June increases from Dinagpur region towards western region of Ishwardi and from Khepupara to Bhola region and from Comilla to southeast region. From the observing data, we saw that, at Sitakundu, Ishwardi, Dhaka, Satkhira, Barisal, Bhola, M.Court, Hatiya and Cox's Bazar, there is a high valus of positive correlation between May & June which is significant at 99% level (Fig4(a)).

June-July: The correlation coefficient of average maximum temperature between June and July increases from western region of Rajshahi towards northeast region of Rangpur and Ishwardi region to Khepupara region. The maximum positive and negative value of the correlation coefficient is observed at Khepupara and Mymensing region and which values are 0.9 and -0.17 respectively (Fig4(b)).

July-August: We observed that the correlation coefficient of average maximum temperature between June and July increases from Rajshahi region towards southwest region of Satkhira and Feni region to southeast region of Teknaf. From the observing data, we see, at Dhaka, Khulna, Satkhira, Jessore, Rangamati and Cox's Bazar, there is a high degree of positive correlation between July and August which is significant at 99% level (Fig4(c)).

August-September: The correlation coefficient of average maximum temperature between August and September increases from Ishwardi region towards southwest region and Sylhet to Bogra region and also increases from Feni region to Dhaka. The maximum positive and negative value of the correlation coefficient is observed at Hatiya and Feni region and which values are 0.5 and -0.14 respectively (Fig4(d)).

3.5 *Correlation coefficient of minimum temperature between the consecutive months of monsoon season*

May-June: We have seen that the correlation coefficient of average minimum temperature between May and June increases from Rajshahi region towards Rangpur region and from Srimangal region to Mymensing region. From the observing data we see that, at Rangpur, Dinajpur, Ishwardi, Sylhet, Mymensing, Faridpur, Jessore, Khulna, Barisal, Bhola, Patuakhali, Feni, Sandwaip, Rangamati, Chittagong, Cox's Bazar, Madaripur, Sitakunda and Teknaf, there is a high positive correlation between May and June, which is significant at 99% level (Fig5(a)).

June-July: The correlation coefficient of average minimum temperature between June and July increases from Ishwardi region towards Madaripur region and from Sylhet region to Mymensing region. From the observing data we see that, at Rangpur, Dinajpur, Srimangal, Mymensing, Faridpur, Satkhira, Bhola, Patuakhali, Comilla, Chandpur, M.Court, Sandwaip, Rangamati, Chittagong, Cox's Bazar, Madaripur, Sitakunda and Teknaf, there is a high degree of positive correlation between June and July, which significant level is 99%. (Fig5(b)).

July- August: The correlation coefficient of average minimum temperature between July and August increases from Patuakhali region towards Faridpur region. From the observing data we see that, at Sylhet, Srimangal, Mymensing, Dhaka, Faridpur, Jessore, Satkhira, Barisal, Patuakhali,

Khepupara, Comilla, Chandpur, Feni, M.Court, Hatia, Sandwaip, Rangamati, Chittagong, Cox's Bazar, Madaripur and Teknaf, there is a high degree of positive correlation between July and August, which is significant at 99% level (Fig5(c)).

August-September: We have seen that the correlation coefficient of average minimum temperature between August and September increases from Rajshahi region towards Khulna region and from Dhaka region to North-West. The maximum positive and negative value of the correlation coefficient is observed at Mymensing and Sitakunda region and which values are 0.96 and -0.01 respectively (Fig5(d)).

Table 1 ***Correlation coefficient between DBT and Rainfall, WBT and Rainfall for the consecutive months of monsoon season over Bangladesh during 1951-2000.***

Month	DBT & Rainfall	WBT & Rainfall
June	-0.7624	-0.6213
July	-0.6456	-0.3277
August	-0.6546	-0.7183
September	-0.2496	-0.2105

The distribution of correlation coefficient between the DBT and WBT with rainfall for months of June, July, August and September are shown in Table 1. We observe that, there is high negative correlation among both of them, which is significant at 99% level except September.

In Tables2-6, the averages of dry bulb temperature, wet bulb temperature, rainfall, maximum temperature and minimum temperature of monsoon season of different divisions of Bangladesh during 1951-2000 are presented.

Table 2 ***The average dry bulb temperature of monsoon season of different divisions over Bangladesh during 1951-2000.***

Divisions	**The average dry bulb temperature** (ºC)
Barisal	28.09
Chittagong	28.29
Dhaka	28.46
Khulna	28.89
Rajshahi	28.54
Sylhet	27.06

Table 3 ***The average wet bulb temperature of monsoon season of different divisions over Bangladesh during 1951-2000.***

Divisions	**The average wet bulb temperature** (ºC)
Barisal	26.43
Chittagong	26.38
Dhaka	26.53
Khulna	26.80
Rajshahi	26.51
Sylhet	25.56

Table 4 ***The average rainfall of monsoon season of different divisions over Bangladesh during 1951-2000.***

Divisions	**The average rainfall** (mm)
Barisal	331.13
Chittagong	377.13
Dhaka	259.38
Khulna	233.35
Rajshahi	303.38
Sylhet	555.75

Table 5 ***The average maximum temperature of monsoon season of different division over Bangladesh during 1951-2000.***

Divisions	**The average maximum temperature** (ºC)
Barisal	31.58
Chittagong	31.85
Dhaka	31.68
Khulna	32.79
Rajshahi	32.13
Sylhet	31.36

Table 6 ***The average minimum temperature of monsoon season of different divisions over Bangladesh during 1951-2000.***

Divisions	**The average minimum temperature** (ºC)
Barisal	25.20
Chittagong	25.26
Dhaka	25.64
Khulna	25.89
Rajshahi	25.83
Sylhet	24.50

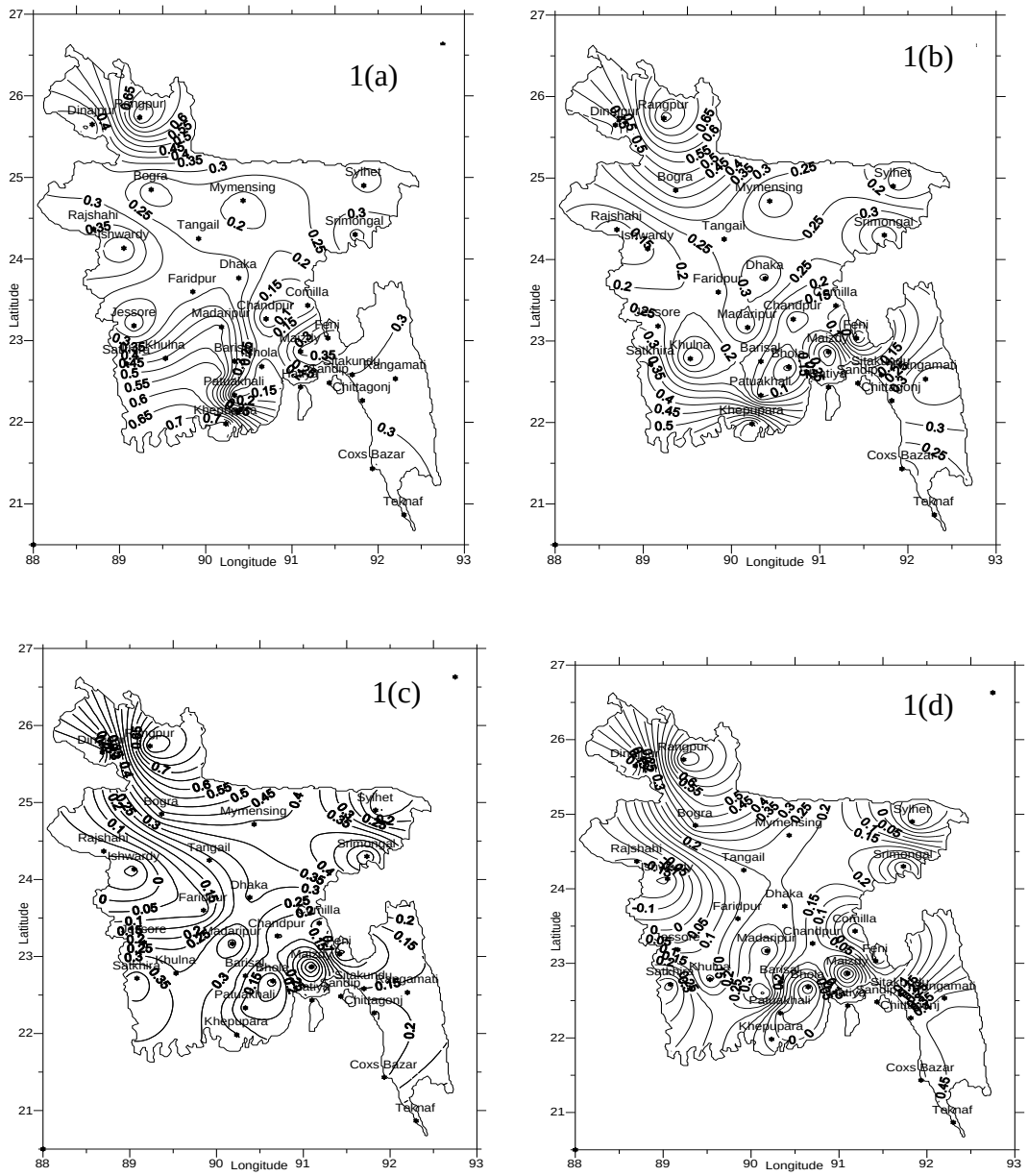


Fig.1 ***Correlation coefficient of monthly mean Dry bulb temperature of May with June 1(a), June with July 1(b), July with August 1(c) and August with September 1(d) by using the data for the period 1951-2000 all over Bangladesh.***

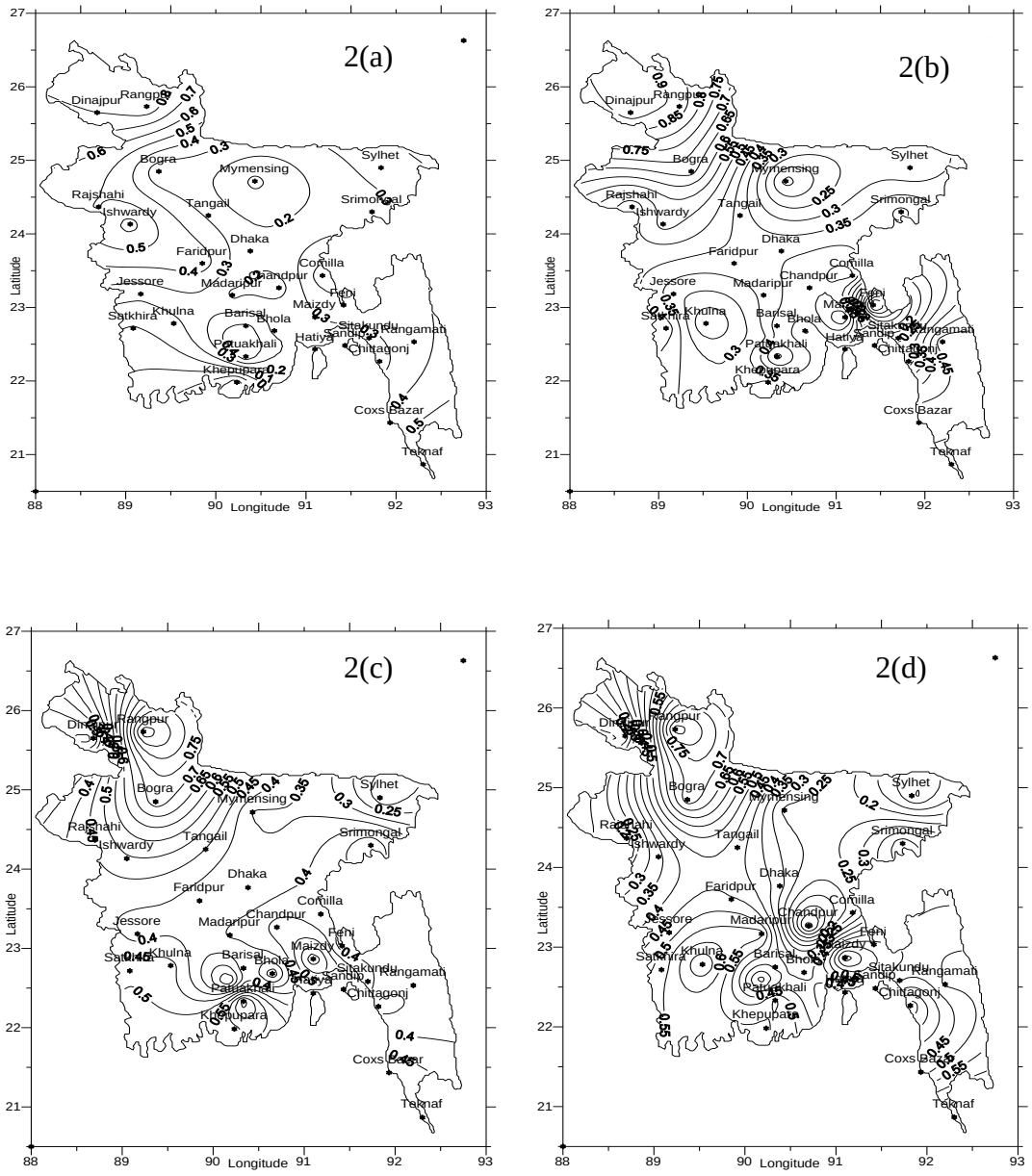


Fig.2 ***Correlation coefficient of monthly mean Wet bulb temperature of May with June 2(a), June with July 2(b), July with August 2(c) and August with September 2(d) by using the data for the period 1951-2000 all over Bangladesh.***

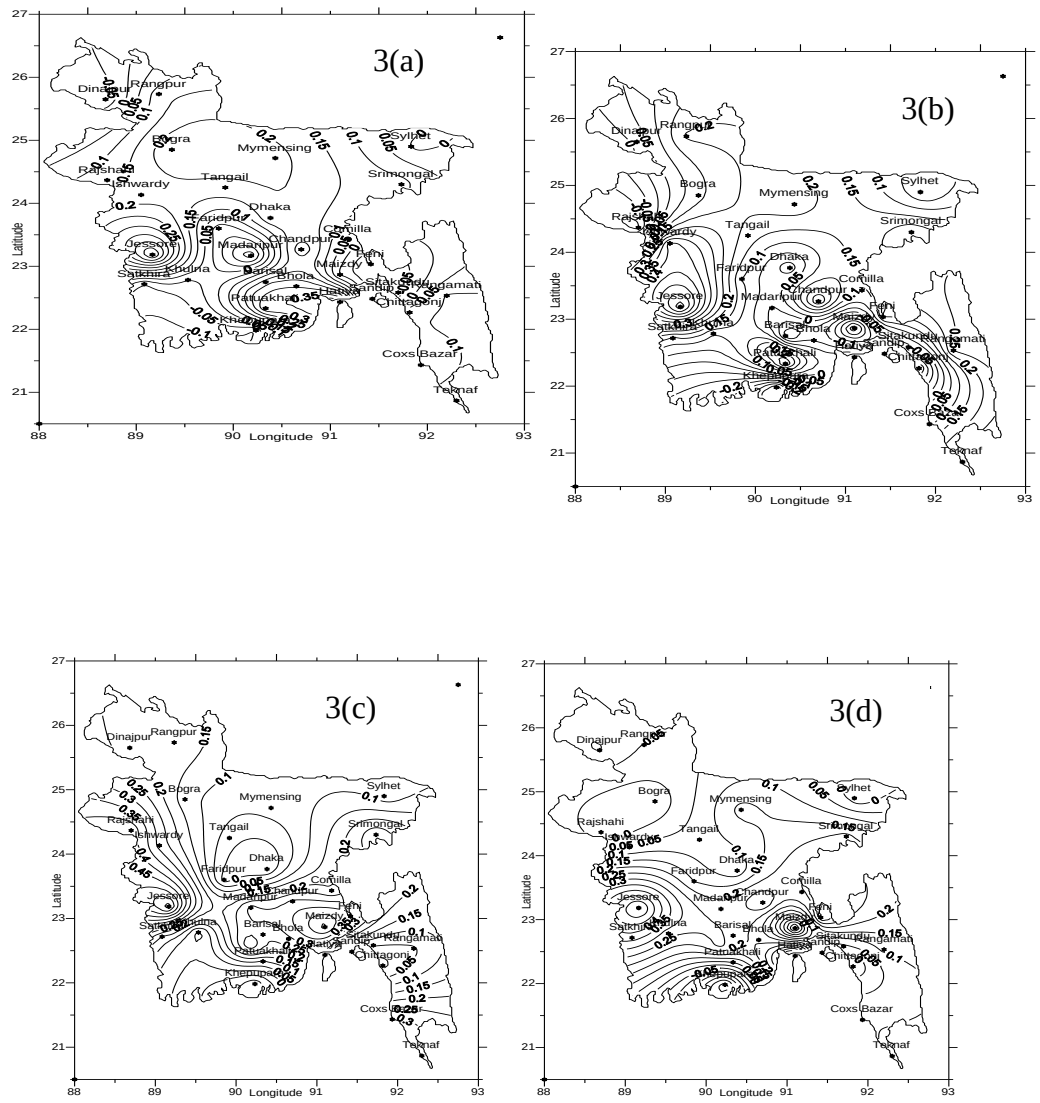
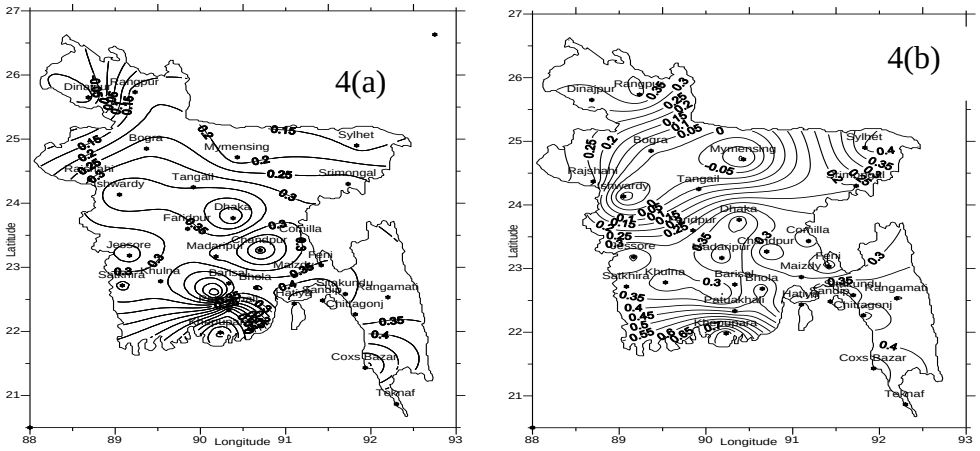


Fig. 3 ***Correlation coefficient of monthly mean rainfall of May with June 3(a), June with July 3(b), July with August 3(c) and August with September 3(d) by using the data for the period 1951-2000 all over Bangladesh.***



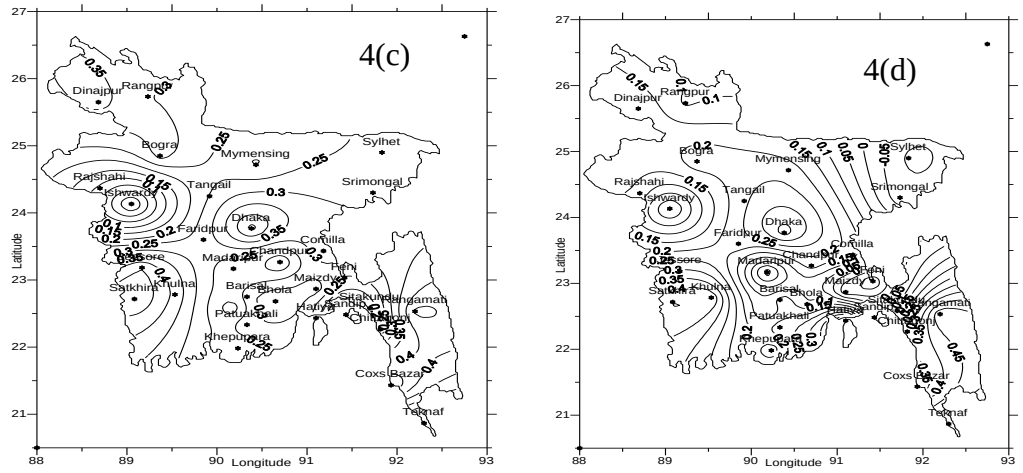
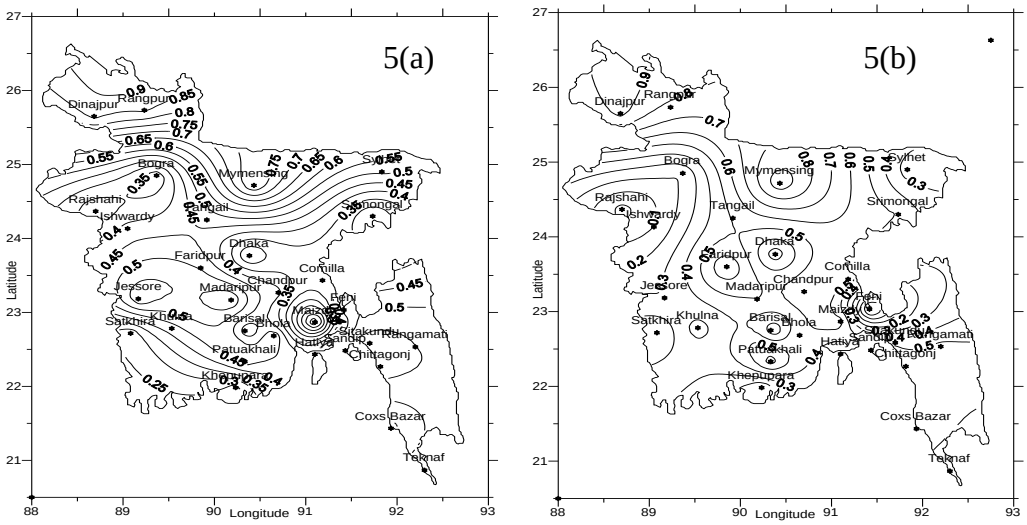


Fig.4 ***Correlation coefficient of monthly mean maximum temperature of May with June 4(a), June with July 4(b), July with 4(c) and August with September 4(d) by using the data for the period 1951-2000 all over Bangladesh.***



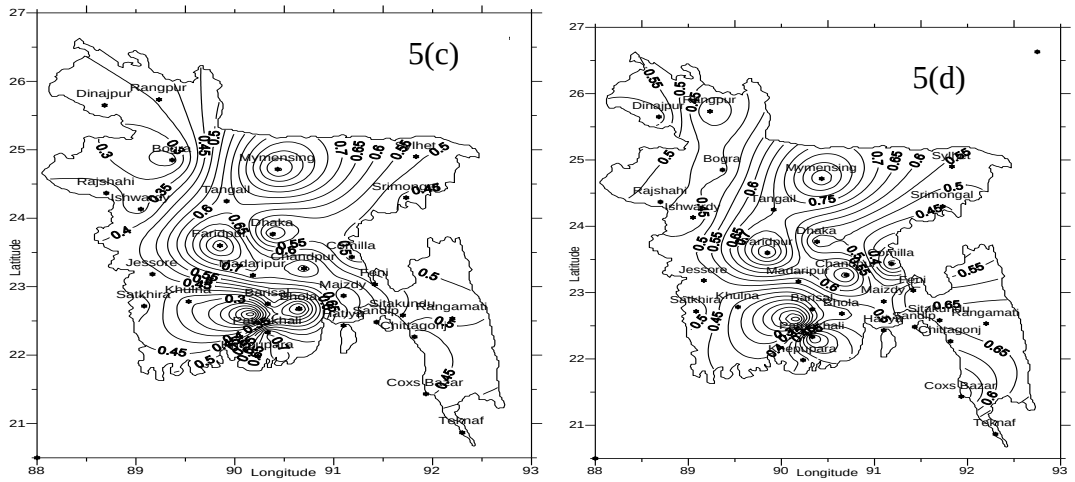


Fig. 5 ***Correlation coefficient of monthly mean minimum temperature of May with June 5(a), June with July 5(b), July with August 5(c) and August with September 5(d) by using the data for the period 1951-2000 all over Bangladesh.***

4. Conclusions

The objective of this investigation is to analyse the Correlation of monthly temperature and rainfall between the consecutive months of the monsoon season. Our study reveals that the correlation coefficients of dry bulb temperature between May and June over all country during 1951-2000 are positive. Except at few stations, the correlation coefficients of wet bulb temperature of the considered months over all Bangladesh are positive and their significant level is 99% in most of the cases. High correlation coefficients of rainfall for all the considered months are seen at Jessore. The correlation coefficients of maximum temperature between the considered months are positive except at few stations during the periods 1951-2000 over Bangladesh. There exists strong correlation between minimum temperatures for all consecutive months except for a few stations. The average lowest and highest rainfall is found in June and July in Khulna and Chittagong division respectively. The average maximum rainfall in monsoon season is shown in Sylhet division and average minimum rainfall is shown

in Khulna during 1951-2000 over Bangladesh, whose magnitude is 555.75 mm and 233.25 mm respectively.

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