MULTIPLE CORRELATION BETWEEN RAINFALL OF POST- MONSOON SEASON AND THE DIFFERENT METEOROLOGICAL PARAMETERS OF THE MONSOON SEASON OVER BANGLADESH

BY

SHAHEENA PERVIN

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Multiple correlation between rainfall of post-monsoon season and the different meteorological parameters of the monsoon season over Bangladesh

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has been accepted as satisfactory in partial fulfillment for the degree of Master of Philosophy in Physics and certify that the student demonstrated a satisfactory knowledge on the field covered by this thesis in an oral examination held on 25 January, 2006.

1.	Professor Dr. Md. Mahbub Alam (Supervisor) Department of Physics Khulna University of Engineering and Technology	Chairman
2.	Head Department of Physics Khulna University of Engineering and Technology	Member
3.	Professor Dr. Shibendra Shekher Sikder Department of Physics Khulna University of Engineering and Technology	Member
4.	Md. Kamrul Hasan Reza Assistant Professor, Department of Physics Khulna University of Engineering and Technology	Member
5.	Dr. Mohammad Arif Hossain Associate Professor, Department of Mathematics Khulna University of Engineering and Technology	Member
6.	Dr. Md. Nazrul Islam Associate Professor, Department of Physics Bangladesh University of Engineering and Technology	Member (External)

CERTIFICATE

This is to certify that this thesis which the candidate has presented for M. Phil degree has been done by the candidate herself and does not contain any material extracted from elsewhere or from a work published by any body else. The work of this thesis has not been presented for another degree or diploma in any other University or Institute. No other person's work has been used without due acknowledgement.

25.02.06
Supervisor

25.02.06
Candidate

TO

MOBAIDUL ISLAM KHAN

AND

BELOVED MY PARENTS

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Abstract

In this thesis work attempt has been made to investigate the correlation between the monthly and seasonal rainfall of post monsoon with the dry bulb and wet bulb temperature and rainfall of different months of monsoon and the season itself. First of all the raw data, collected from BMD, has been processed to obtain monthly and seasonal average of them. Also the standard deviation in terms of months and seasons have been computed. Using the processed data the correlation coefficients have been computed.

We have considered 30 stations all over Bangladesh under all 6 divisions during 1951 – 2000. The computations are made station wise. In this process we have analyzed the following topics: -

- Averages dry bulb temperature (DBT) and wet bulb temperature (WBT) of the month of June, July, August and September and of monsoon season. Average rainfall of the month of June, July, August, September, October and November and of monsoon and post monsoon season.
- The Standard deviation of all the above mentioned cases.
- Correlation coefficients between the monthly / seasonal rainfall of post monsoon and monthly / seasonal DBT, WBT and rainfall of monsoon season. Correlation coefficients between the monthly / seasonal rainfall of post monsoon and monthly / seasonal DBT & WBT, WBT & rainfall, DBT & rainfall of monsoon season. And finally correlation coefficients between the monthly / seasonal rainfall of post monsoon and monthly / seasonal DBT, WBT & rainfall of monsoon season.

From the analysis we have found that in October the amount of rainfall at Sandwip and Patuakhali is the highest and that in the November is at Bhola and Cox's Bazar region. In November the Standard deviation of average rainfall is comparatively high in the southern region. We also observe that November rainfall and WBT of monsoon months are positively correlated except northeast-southern region in July and northeast and Bhola region in June and August of the country.

Also regression equations have been developed on considering October and November rainfall as dependent variable and dry bulb temperature, wet bulb temperature and rainfall of monsoon as independent variables. Where the correlation coefficients are high, there these equations will be useful for the prediction purpose.

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CHAPTER I

Introduction

Climate is the most important phenomenon for life on the earth. It is not constant but changing continuously. On the basis of climate in Bangladesh there are two seasons namely dry season and rainy season. Dry season is termed is as winter and rainy season is divided into a) pre-monsoon, b) monsoon and c) post-monsoon. Monsoon season is the most important for rainfall in and around Bangladesh and pre-monsoon and post-monsoon seasons are important for severe cyclone formation in the Bay of Bengal. The effects of these cyclones are tremendous for Bangladeshi people.

Rain has always been valued by mankind, because good crops and abundant water supplies are possible only by timely and plentiful rainfall. Rain in general, brings with it a sense of hope, vitality and promise for the future.

The impact of Indian sub-continental rainfall is tremendous in monsoon season. In this season sometime amount of rainfall occurs in the upper catchement area of Bangladesh (Nepal and Northeast India), which causes flood in the Northeast India and Bangladesh. Almost all the rainwater, falling in the upper catchement area flows over Bangladesh and sometimes the country faces heavy flood. The flood that occurred in the recent past viz. 1987, 1988, 1998 and the last year 2004 are of remembrance. It is also observed that when flood is occurring in the Northeast India and Bangladesh, at the same time drought is occurring in the west part of India. 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. The green house gases has also increase in the atmosphere.

Summer Monsoon season is the most important and vital one for the people who live in the Indian subcontinent. The East Asian summer monsoon has complex space and time structures that are distinct from the South Asian monsoon. On an average, the onset occurs in the first week of June in Bangladesh and mid May in India when heavy convective rainfall occurs. The elongated rain belt during the monsoon season normally moves northward direction.

Most of the Severe Cyclonic Storms with core of hurricane winds form in the pre-monsoon and post-monsoon season in the Bay of Bengal. The effects of these cyclones are tremendous for the people of this subcontinent. The cyclone in the 12 November 1970 and 29 April 1991 causes unmeasurable losses of lives and properties due to storm surge, high wind and rain in recent years. The number of depressions / tropical cyclones forming

in the Bay of Bengal has decreased sharply (Alam et al. 2002). Most probably this is happening due to the climatic variations in the East, Far East Asia and Indian sub continental region. Also the coupled ocean-atmospheric phenomenon in the Tropical Indian Ocean and the coupled land-ocean-atmospheric interactions may be the one of the causes of climatic variations in the Indian subcontinent.

The degree of predictability of post-monsoon rainfall is a matter of considerable social and economic importance. The amounts of Rainfall generally vary from place to place and month to month. For the purpose of agricultural, industrial and hydrological planning and water management, it is very important to know the average amount of the variability of rainfall, which can be expressed in terms of its probabilistic occurrence.

Studies on rainfall characteristics of Bangladesh are a few. A preliminary investigation of the water balance of the country was done by Khan and Islam (1966) while the variability of annual rainfall by Shamsuddin (1974), spatial and temporal variability by Samad and Islam (1993), monsoon seasonally and aspects of hydrology, agriculture by Shamsuddin and Alam (1990), correlation between winter temperature and post-monsoon rainfall by Alam and Hossain (2004) and correlation between winter temperature and monsoon rainfall over Bangladesh by Alam (2000) are among the significant contributions towards understanding of rainfall characteristics and distribution in Bangladesh.

The southwest monsoon begins its withdrawal from 30th September and the withdrawal is completed through the southeastern part of the country 17 days later (Ahmed and Karmakar, 1993). The variations of rainfall in different seasons are well known. However, it is generally expected that direct correlation may exist between the rainfall and temperature. Though the southwest monsoon is the major rainfall season for Bangladesh, the post-monsoon or northeast monsoon is also important. Raj (1989) has shown that the August – September 150 hPa mean zonal wind of Trivandrum is capable of giving satisfactory forecasts for the post monsoon rainfall of Tamilnadu. Upadhyay et al., (1990) and Kanaujia et al., (1992) determined the rainfall correlation structure over India and concluded that space rainfall correlation decreases exponentially with distance. Karmakar et al., (1994) has not observed any correlation between pre-monsoon and monsoon rainfall over different stations of Bangladesh. Banerjee et al., (1978) showed that the total monsoon rainfall over India is significantly correlated with the latitudinal position of the subtropical ridge of the mean circulation of April at 500 hPa level. Ohsawa

et al., (2000) studied the time-lag correlation of the 20-day mode of the 850 hPa zonal wind with a reference point at 22.5^0N, 90^0E for the periodicity of monsoon activity.

The southwest monsoon enters Bangladesh through the southeastern region, i.e., Cox's Bazar, then moves north wards up to Shillong plateau across Sylhet region and finally moves westward (Ahmed and Karmakar 1993). The mean arrival dates of the summer monsoon in the extreme southeastern coastal part and in the extreme northwestern part of Bangladesh are 2 June and 15 July respectively. Mean withdrawal dates of the summer monsoon from the extreme northwestern part and extreme southeastern part of the country are September and 17 October respectively. During the southwest monsoon, Bangladesh receive about 75-80% of the total annual rainfall.

The analysis of annual rainfall for the Bangladesh region for the period 1870-1991 showed no discernible long- term trend in mean- annual rainfall. Karmakar and Nessa (1997) studied climate change and its impacts on natural disasters and southwest monsoon in Bangladesh and the Bay of Bengal. They found that the decadal mean annual temperature over Bangladesh have shown increasing tendency especially after 1961-1970. The projected values of increasing rainfall during the southwest monsoon season, the rainfall is likely to increases by 12.74 mm and 23.36 mm by 2050 and 2100 years respectively. During the post-monsoon season, the rainfall is likely to increases by 14.05 mm and 25.76 mm by 2050 and 2100 years respectively (Karmakar and Shrestha, 2000).

There is no any study to find out the correlation between post-monsoon rainfall and different meteorological parameters of monsoon season over Bangladesh.

1.1 Monsoon

The "Southwest Monsoon" is used both for the phenomena of rains and southwesterly surface winds and the period during which they occur. Though the Arabic word 'Mausam' simply means 'Season', in meteorological parlance, monsoon or monsoonal effect has come to mean the seasonal reversal of wind and in that sense the term has been used to describe such changes even in higher latitudes and stratospheric winds. Over most of India and Southeast Asia, colossal differences are noticed from preceding or following months or Northeast Monsoon.

The summer low over the northwest India and Pakistan intensifies in June and extends its trough to Bangladesh and adjoining north of the Bay of Bengal. The surface wind changes to southerly direction over the southern and the central districts and to

southeasterly to easterly over the northern districts of the country. Wind speed is light to moderate.

With the advent of the monsoon, the extreme temperatures of summer fall appreciably throughout the country. 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].

Over most parts, the southwest monsoon rainfall is one order of magnitude more than in the rest of the year, so that both the annual and monsoon seasonal isohyets are very similar. Most of the annual rainfall of the densely populated areas of the world, viz. India, southeast Asia, Japan and parts of China is due to the phenomenon of the southwest monsoon and meteorologists should spare no effort to fully unravel its various facts [Rao, 1976].

Ramage (1971) has defined the monsoon area by the following criteria:

- The prevailing wind direction shifts by at least 120° between January and July.
- The average frequency of prevailing wind directions in January and July exceeds 40 percent.
- The mean resultant wind is at least one of the months exceeding 3 m/sec.
- Fewer than one cyclone-anticyclone alternation occurs every two years in either month in a 5 ° latitude-longitude rectangle.

The area between 35° N and 25° S and 30° W and 170° E satisfies this definition and India and the surrounding seas fall within this area. In India and its surroundings, monsoon period is divided into three viz. a) Pre-monsoon (March to May), b) Monsoon (June to September), and c) Post-monsoon (October to November) [Das, 1995].

1.2 Dry bulb temperature (DBT)

The dry bulb temperature usually referred to as air temperature, is the air property that is most common used. When people refer to the temperature of the air, they are normally referring to its dry bulb temperature. The dry bulb temperature refers basically to the ambient air temperature. It is called "Dry Bulb" because the air temperature is indicated by a thermometer not affected by the moisture of the air. Dry bulb temperature T_{db}, can be measured using a normal thermometer freely exposed to the air but shielded from

radiation and moisture. The temperature is usually given in degrees celsius (^{0}C) and the SI unit is Kelvin (^{0}K). The dry bulb temperature is an indicator of heat content and is shown along the bottom axies of the Psychrometric chart. Constant dry bulb temperatures appear as vertical lines in the Psychrometric chart.

1.3 Wet bulb temperature (WBT)

The wet bulb temperature is the temperature of adiabatic saturation. This is the temperature indicated by a moistened thermometer bulb exposed to the airflow. The latent heat for the change of state of the liquid water (or ice) into water vapour is supplied by the sample of air itself. As a result, the air sample may be cooled to a temperature at which it is saturated. This is known as the wet bulb temperature (WBT).

At constant pressure, there are two separate ways of producing saturation: (1) by lowering the temperature to the dew point by means of cooling without any change in the water vapour content, (2) by evaporating water into the air without adding or removing sensible heat. It is necessary to know how much water has to be evaporated to produce saturation and what the temperature at saturation will be. It is not a simple matter of raising the moisture content to that required for saturation at the initial temperature of the air, because the temperature will decrease owing to the evaporative cooling. In other words we cannot raise the dew point to the initial temperature because the latter will falling and they will meet somewhere at any intermediate temperature point. The wet bulb temperature may be determined by means of a psychrometer, which consists of a dry and a wet bulb thermometer.

1.3.1 Measurement of wet and dry bulb temperature

When a psychrometer is used to measure the air is caused to move rapidly past two thermometer bulbs. One of these is dry and indicates the air temperature. The other is covered with a moist cloth and comes to thermal equilibrium at a temperature below that of the air, because the wet bulb is cooled by evaporation of some of its moisture. When thermal equilibrium has been reached at WBT, the loss of heat by the air flowing past the wet bulb must be equal to the sensible heat, which is transformed to latent heat. That is

$$(T - T_w)(C_p + \omega C_{pv}) = (\omega' - \omega)L$$

where T is the temperature of the air approaching the wet bulb, T_w is the temperature of the saturated air leaving the wet bulb, C_P is the specific heat at constant pressure of dry

air, C_{pv} is the specific heat of water vapour, ω is the mixing ratio of the approaching unsaturated air, ω' is the mixing ratio of the leaving saturated air and L is the latent heat of evaporation.

If the air is humid, only a small amount of moisture will evaporate from the cloth. This means the wet bulb temperature will only be a little lower than the dry bulb temperature. Conversely, if the moisture will evaporate from the cloth quickly. This means that the wet bulb temperature will be much lower than the dry bulb temperature. If it is raining or there is heavy fog, the air is saturated, and the dry bulb temperature will be equal to the wet bulb temperature.

Wet bulb temperature (WBT) is a temperature associated with the moisture content of the air. WBT is taken by surrounding the thermometer with a wet wick and measuring the reading as the water evaporates. WBT are always lower than DBT and the only time that they will be the same is at saturation (i.e.100% relative humidity). Wet bulb temperature is represented by lines that slant diagonally from the upper right of the psychrometric chart (along the line of saturation) down to the lower left of the psychrometric chart. The unit of measure used for wet bulb temperature is ^{0}C.

1.4 Rainfall

The rainfall distribution in the principal rainy season of India, the southwest monsoon period, lasting from June to September. Except in Kashmir and neighborhood, the extreme south Peninsula and the East Coast areas, the annual rain is mainly accounted for the falls in this season. Orographic influence is dominant in the distribution of rainfall in this season, as the prevailing winds blow almost at right angles against the Western Ghats and the Khasi-Jaintia hills. There is rapid increase of rainfall to the north of a line running from Ahmednagar to Masuliptanam up to the southern slopes of the Vindhyas. In the north Indian plains, a minimum rainfall belt runs from northwest Rajasthan to the central parts of West Bengal, practically along the axis of the monsoon trough. Rainfall decreases generally from the hills of the western and Eastern Ghats towards the coast [Rao, 1976].

Rainfall decreases very rapidly southwards along West Coast from 9.5° N to Kanyakumari. The rainfall at Kanyakumari in this season is about the same as in the Great Indian Desert. To the east of the Western Ghats between 8° N and 10° N, rainfall decreases considerably with a very steep gradient across the eastern slopes. Rainfall is

only 20 mm in some places in the coastal strip in extreme south Tamil Nadu. With all the significant amounts of rainfall occurring over the Ghats, a saving feature of economic interest is that all the important rivers of South India emerge out of the Western Ghats to flow east through the plains having rainfall of the order of that in west Rajasthan.

Hills and mountain ranges cause striking variations in rainfall distribution. On the southern slopes of the Khasi-Jaintia hills annual rainfall is over 8000 mm while to the north, in the Brahmaputra valley, it drops to about 1200 mm. Cherrapunji's annual rainfall of 11420 mm (at elevation of 1313 m) is obviously due to orographic lifting but its magnitude requires that to be quantitatively explained. From the West Coast, rainfall increases along the slopes of the Western Ghats and rapidly decreases on the eastern lee side. In the higher reaches of the Western Ghats, there are places with seasonal rainfall of 5000 mm. Within 80 km on the lee side, rainfall is only 400 mm [Rao, 1976].

In the northwestern parts of the subcontinent rainfall progressively decreases westwards, from 400 mm in Rajasthan to 50 mm in Baluchistan. Southwest Srilanka and the hills get good rains at this time but not the other parts of the island.

Across northern India, a line of rainfall minimum runs from 28.5 ° N, 75 ° E to 25 ° N, 88° E that is paradoxically close to the monsoon trough. Area to the south of this rainfall minimum falls in the track of monsoon depressions, which are responsible for much of the rainfall. In tracts further to north, there is probably the influence of the Himalayas in increasing the rainfall. Apart from this, there is also a decrease of rainfall from east to west, from about 1200 mm in West Bengal to less than 200 mm in the Great Indian Desert in west Rajasthan.

Rainfall in the Andaman and Nicobar Islands during the southwest monsoon season is about 1400 to 1900 mm, while in Laccadives (Minicoy and Aminidivi Islands) and Maldives in the Arabian Sea, it is only about 1000 mm though both the groups are in the same latitude belt. Calicut on the mainland in the West Coast, however, gets 2330 mm more than the Bay Islands [Rao, 1976].

Monsoon normally reaches the coastal districts of Bangladesh by the last week of May to first week of June and progressively engulfs the whole country through June. Generally heavy to very heavy rain with overcast skies characterizes the season. On the average there are 20-25 rainy days per month during June to August, decreasing to 12-15 days in September. More than 75% of the total annual rainfall occurs in this season. The

rainfall is greater over the northeastern, the southern and the southeastern districts than over the central, western and northwestern districts. During the first two months of the season the rainfall is between 450-600 mm per month over the northern and southern districts and it is 700-850 mm per month over the district of Sylhet and the southeastern districts of Chittagong and Chittagong Hill Tracts. Over the central districts, the rainfall is 250-380 mm per month in the two months. The rainfall over the country decreases gradually as the season advances. In September the rainfall is 200-250 mm over the country except in the district of Sylhet and the coastal districts of Barisal, Noakhali, Chittagong and Chittagong Hill Tracts, where the rainfall is 300-450 mm [WMO/UNDP/BGD/79/013, 1986].

1.5 Post-Monsoon

Monsoons normally retreat by the middle of September. With this a gradual change in weather takes place and continuous so till the end of November. Thus October and November are the months with transitional climates between rainy and winter seasons. The weather remains generally dry and fair. Southwest monsoon begins to withdraw from the country; withdrawal is complete through October.

There is a general rise of pressure and the monsoon pressure structure breaks down over the country. The monsoon low over the central India weakens and shifts towards the Bay of Bengal with its trough extending over the coastal Bangladesh.

The surface wind is very light and variable. Rainfall decreases considerably in October and in November the dry period starts setting in over the country. The district of Sylhet gets 200-250 mm of rain in October and the rest of the country gets about 100-170 mm. In November the amount of rainfall over the southeastern coastal districts amount to 25-65 mm whereas the rest of the country gets only about 10-20 mm of rain. In October there are 4-10 days of rainfall over the country and only 1-3 days in the month of November.

In the post-monsoon period Srilanka, the south peninsula, Assam and parts of Kashmir are the chief areas of rainfall. From the east coast of India rainfall decreases towards inland, markedly so in Tamilnadu and Andhra Pradesh. South of 15^0N, rainfall again increases over and near the Western Ghats but decreases towards the west coast. The increase in rainfall near the Eastern Ghats is not marked. In Srilanka the East coast

gets good rains and so does the southwest. The eastern coastal belt of the Peninsula and the whole of Srilanka gets more rain from post monsoon, than in other period.

However, at the hill station of Nuwara Eliya, June- September is the main raniy season. The rains of October- December are popularly referred to as the "northeast monsoon" on account of the direction of the surface winds that blowing over most parts of the Bay of Bengal.

Tropical depressions and storms form in the Bay of Bengal during is season and generally more to the northwest or north towards India and Bangladesh coasts. Most of the storms attain hurricane intensity in this season.

In this work, we have tried to investigate the correlation between the monthly rainfall of post-monsoon season with the average monthly Dry Bulb Temperature, Wet Bulb Temperature and Rainfall of different months of monsoon season. We have also tried to find the correlation between the seasonal average rainfall of post monsoon season with seasonal average Dry Bulb Temperature, Wet Bulb Temperatures and Rainfall of monsoon season.

Also regression equations are developed, for each stations under consideration, which are usable to predict the rainfall for the months of October and November on the basis of the DBT, WBT and rainfall of the monsoon.

CHAPTER II

Methodology

2.1 Average

The arithmetic mean also referred to as the arithmetic average or simply as the mean, is the central value of the items in a series. It is obtained by dividing the total value of the items in a series by the number of items. It is computed by taking into consideration all the values in the series and cannot be located by studying the position of the values in the series.

Let variables be denoted by x and x_1, x_2, x_3.....x_n denote the values which x may assume. These values may or may not be different. The sum may be written as

$$\sum x = x_1 + x_2 + x_3 + ... + x_n$$

$$\text{then } \bar{x} = \sum_{i=1}^{n} x_i / n$$

where, x_i = Individual observation

n = Number of observation

$\bar{x}$ = Mean or average of observation.

We have calculated the mean of Dry bulb temperature, Wet bulb temperature and rainfall of each months of monsoon and rainfall of each months of post-monsoon for all the stations all over Bangladesh under consideration.

2.2 Standard Deviation (SD)

A standard deviation is by far most important measure of dispersion. It is highly enabled to mathematical treatment and comparatively stable under fluctuations of sampling. If computation is of prime concern the standard deviation is almost invariably used as a precise measure of dispersion. Standard deviation is the positive square root of the mean of the squares of the deviations of the given values forms their mean. Mathematically it is denoted as:

$$S.D. = \left(\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2\right)^{1/2}$$

where, S.D.= Standard deviation.

N = Number of observation.

x_i = Individual observation.

$\overline{x}$ = Mean of the observation.

2.3 Regression

The study of correlation coefficient merely tells us whether there is a going togetherness or relationship between the variables and the extent of relationship existing between them. But it fails to give us a measure of the probable movements of one variable in terms of the other. For estimating the probable movement in one variable in terms of the other we are to resort to regression analysis. Literally to regress means to return and, therefore, Regression means something like returning or passing back.

By regression analysis we study the average change in one variable in terms of the other. It enables us to see or predict the average effect that would be caused in one variable as a result of the change in another variable. One of the variables is taken as the subject and another as relative. Measurements of the probable movement of one variable in terms of the other involve the fitting of regression lines.

2.3.1 Regression equations

A regression equation is an equation for estimating dependent variable, say x_1, from the independent variables X_2, X_3, X_4.....and is called a regression equation of X_1 on (X_2 ,X_3, X_4.....), In functional notation this is sometimes written briefly as X_1=F (X_2, X_3, X_4.....).

For the case of four variables, the simplest regression equation of X_1 on X_2, X_3 and X_4 has the form

$$X_1=b_{1.234}+b_{12.34}X_2+b_{13.24}X_3+b_{14.23}X_4 \qquad (2.3.1)$$

where $b_{1.234}$, $b_{12.34}$, $b_{13.24}$ and $b_{14.23}$ are constants. If we keep X_4 constant in equation (2.3.1), the graph of X_1 versus X_2 and X_3 is a plane with direction ratios $b_{12.34}$ and $b_{13.24}$. If we keep X_3 constant, the graph of X_1 versus X_2 and X_4 is a plane with direction ratios $b_{12.34}$ and $b_{14.23}$. If we keep X_2 constant, the graph of X_1 versus X_3 and X_4 is a straight line with slope

$b_{13.24}$ and $b_{14.23}$. It is clear that the subscripts after the dot indicate the variables held constant in each case.

When X_4 is taken as constant, due to the fact that X_1 varies partially because of variation in X_2 and partially because of variation in X_3 we call $b_{12.34}$ as *partial regression coefficients* of X_1 on X_2 keeping X_3 and X_4 constant.

Just as there exist least-squares regression lines approximating a set of N data points (X,Y) in a two dimensional scatter diagram, so also there exist least-square regression hyper planes fitting a set of N data points (X_1, X_2, X_3, X_4) in a four- dimensional scatter diagram.

The least-squares regression hyper plane of X_1 on X_2, X_3 and X_4 has the equation (2.3.1) where $b_{1.234}$, $b_{12.34}$, $b_{13.24}$ and $b_{14.23}$ are determined by solving simultaneously the normal equations

$$\sum X_1 = b_{1.234}N + b_{12.34}\sum X_2 + b_{13.24}\sum X_3 + b_{14.23}\sum X_4$$

$$\sum X_1X_2 = b_{1.234}\sum X_2 + b_{12.34}\sum X_2^2 + b_{13.24}\sum X_2X_3 + b_{14.23}\sum X_2X_4 \qquad (2.3.2)$$

$$\sum X_1X_3 = b_{1.234}\sum X_3 + b_{12.34}\sum X_2X_3 + b_{13.24}\sum X_3^2 + b_{14.23}\sum X_3X_4$$

$$\sum X_1X_4 = b_{1.234}\sum X_4 + b_{12.34}\sum X_2X_4 + b_{13.24}\sum X_3X_4 + b_{14.23}\sum X_4^2$$

These can be obtained formally by multiplying both sides of equation (2.3.1) by 1, X_2, X_3 and X_4 successively and summing on both sides.

If $x_1 = X_1 - \overline{X_1}, x_2 = X_2 - \overline{X_2}, x_3 = X_3 - \overline{X_3}$ *and* $x_4 = X_4 - \overline{X_4}$, the regression equation of X_1 on X_2, X_3, and X_4 can be written more simply as

$$x_1 = b_{12.34}x_2 + b_{13.24}x_3 + b_{14.23}x_4 \qquad (2.3.3)$$

where $b_{12.34}$, $b_{13.24}$ and $b_{14.23}$ can be obtained from the normal equation

$$\sum x_1x_2 = b_{12.34}\sum x_2^2 + b_{13.24}\sum x_2x_3 + b_{14.23}\sum x_2x_4$$

$$\sum x_1x_3 = b_{12.34}\sum x_2x_3 + b_{13.24}\sum x_3^2 + b_{14.23}\sum x_3x_4$$

$$\sum x_1 x_4 = b_{12.34}\sum x_2 x_4 + b_{13.24}\sum x_3 x_4 + b_{14.23}\sum x_4^2$$

These equations which are equivalent to the normal equations (2.3.2) can be obtained formally by multiplying both sides of equation (2.3.3) by x_2, x_3 and x_4 successively and summing on both sides.

2.4 Simple correlation

The elementary principles of two-variable linear correlation

$$Y_c = a + bX \text{ .....(1)}$$

This permitted us to make estimates of the value of the dependent variable from values of the independent variable. Next it was demonstrated that the total variation of the dependent variable was the sum of (1) The explained variation and (2) The variation which we had failed to explain by our hypothesis; that is

$$\sum y^2 = \sum y_c^2 + \sum y_s^2 \text{ .....(2)}$$

It should be remembered that we computed Σy^2 by the formula.

$$\sum y^2 = \sum Y^2 - \bar{Y}\sum Y; \text{.....(3)}$$

And that Σy_c^2 was computed from the expression.

$$\sum y_c^2 = \sum Y_c^2 - \bar{Y}\sum Y;$$

In which

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

or, more simply

$$\sum y_c^2 = b\sum xy.$$

$\sum y_s^2$ was obtained by subtracting the explained variation from the total variation; that is.

$$\sum y_s^2 = \sum y^2 - \sum y_c^2 \ .$$

Finally, a measure was computed that permitted us to state the proportion of total variation which had been explained by variations in the computed values of the dependent variable. This ratio,

$$r^2 = \frac{\sum y_c^2}{\sum y^2}.$$

was known as the coefficient of determination, and its square root was called the coefficient of correlation.

2.5 Multiple correlation

Exactly the same principles are involved in multiple correlation as in simple correlation, but the procedure is more laborious, since there is more than one independent variable. Also, it is necessary to use slightly different symbols. The illustration in this chapter will deal with the relationship between rainfall of post monsoon season, and Dry bulb temperature, wet-bulb temperature and rainfall of monsoon season. Rainfall of post monsoon season is the dependent variable, and the other three are independent variables.

It simplifies the notations somewhat if, instead of using different letters, each of the variables is designated by the letter X, differentiating between the variables by means of subscripts. This is particularly true if the number of variables is large. We shall therefore designate our variables in this manner:

Dependent variable

Rainfall of post monsoon season	X_1

Independent variables:

Dry-bulb temperature (DBT)	X_2
Wet- bulb temperature (WBT)	X_3
Rainfall of monsoon season	X_4

We use an estimating equation of the type

$$X_{c1.234} = a_{1.234} + b_{12.34} X_2 + b_{13.24} X_3 + b_{14.23} X_4$$

The Coefficient of multiple determinations and the coefficient of multiple correlations are,

$$R^2_{1.234} = \frac{\sum X^2_{c1.234}}{\sum x_1^2}$$

This expression is put into a general form for four variables by writing multiple correlation between X_1 and X_2, X3, X4 can be written as:

$$R^2_{1.234} = 1-\left[\left(1-r^2_{12}\right)\left(1-r^2_{132}\right)\left(1-r^2_{1423}\right)\right]$$

2.5.1 Multiple correlation of 3 variables

Multiple correlation deals with the combined or total influence of a group of independent variables. Let us wider a dependent variables y and independent variables are X_1 and X_2 i.e. 1, 2. The multiple co-relation co-efficient $R_{y,12}$ can be calculated as:

$$R^2_{y.12} = \frac{r^2_{1y}+r^2_{2y}-2r_{1y}r_{2y}r_{12}}{1-r^2_{12}}$$

where r_{1y}, r_{2y}, r_{12} are the coefficients of correlation:

$$r_{1y} = \frac{\sum(x_{1i}-\bar{x}_1)(y_i-\bar{y})}{\sqrt{\sum(x_{1i}-\bar{x}_1)^2(y_i-\bar{y})^2}}$$

$$r_{12} = \frac{\sum(x_{1i}-\bar{x}_1)(x_{2i}-\bar{x}_2)}{\sqrt{\sum(x_{1i}-\bar{x}_1)^2(x_{2i}-\bar{x}_2)^2}}$$

$$r_{2y} = \frac{\sum(x_{2i}-\bar{x}_2)(y_i-\bar{y})}{\sqrt{\sum(x_{2i}-\bar{x}_2)^2(y_i-\bar{y})^2}}$$

Multiple correlation between Rainfall of post Monsoon season and Dry bulb temperature (DBT), Wet bulb temperature (WBT) of Monsoon season can be written as

$$R^2_{1.23} = \frac{r^2_{12} + r^2_{13} - 2r_{12}r_{13}r_{23}}{1 - r^2_{23}}$$

Where r_{12}, r_{13}, r_{23} are the simple r of Rainfall of post monsoon season and DBT of monsoon season, Rainfall of post monsoon season and WBT of monsoon season, DBT of monsoon season and WBT of monsoon season respectively.

$$r_{12} = \frac{\sum (x_{1i} - \bar{x}_1)(x_{2i} - \bar{x}_2)}{\sqrt{\sum (x_{1i} - \bar{x}_1)^2 (x_{2i} - \bar{x}_2)^2}}$$

$$r_{13} = \frac{\sum (x_{1i} - \bar{x}_1)(x_{3i} - \bar{x}_3)}{\sqrt{\sum (x_{1i} - \bar{x}_1)^2 (x_{3i} - \bar{x}_3)^2}}$$

$$r_{23} = \frac{\sum (x_{2i} - \bar{x}_2)(x_{3i} - \bar{x}_3)}{\sqrt{\sum (x_{2i} - \bar{x}_2)^2 (x_{3i} - \bar{x}_3)^2}}$$

2.5.2 **Multiple correlation for 4 variables**

Multiple correlation between Rainfall of post monsoon season (1) and DBT (2), WBT (3), Rainfall (4) of monsoon season can be written as

$$R^2_{1.234} = 1 - \left[(1 - r^2_{12})(1 - r^2_{132})(1 - r^2_{1423}) \right] \qquad (2.4.1)$$

Suffix 1 indicates that average Rainfall of October, November and post monsoon suffix 2 indicates that average DBT of June, July, August, September and monsoon suffix 3 indicates that average WBT of June, July, August, September and monsoon and suffix 4 indicates that average rainfall of June, July, August, September and Monsoon season.

In this way we can calculate Rainfall of post monsoon season and DBT of monsoon season (r_{12}), Rainfall of post monsoon season and WBT of monsoon season (r_{13}), Rainfall of post monsoon season and Rainfall of monsoon season (r_{14}), DBT and WBT of monsoon season (r_{23}), DBT and

Rainfall of monsoon season (r_{24}), WBT and Rainfall of monsoon season (r_{34}) respectively.

$$r_{12} = \frac{\sum (x_{1i} - \bar{x}_1)(x_{2i} - \bar{x}_2)}{\sqrt{\sum (x_{1i} - \bar{x}_1)^2 (x_{2i} - \bar{x}_2)^2}}$$

$$r_{13} = \frac{\sum (x_{1i} - \bar{x}_1)(x_{3i} - \bar{x}_3)}{\sqrt{\sum (x_{1i} - \bar{x}_1)^2 (x_{3i} - \bar{x}_3)^2}}$$

$$r_{14} = \frac{\sum (x_{1i} - \bar{x}_1)(x_{4i} - \bar{x}_4)}{\sqrt{\sum (x_{1i} - \bar{x}_1)^2 (x_{4i} - \bar{x}_4)^2}}$$

$$r_{23} = \frac{\sum (x_{2i} - \bar{x}_2)(x_{3i} - \bar{x}_3)}{\sqrt{\sum (x_{2i} - \bar{x}_2)^2 (x_{3i} - \bar{x}_3)^2}}$$

$$r_{24} = \frac{\sum (x_{2i} - \bar{x}_2)(x_{4i} - \bar{x}_4)}{\sqrt{\sum (x_{2i} - \bar{x}_2)^2 (x_{4i} - \bar{x}_4)^2}}$$

$$r_{24} = \frac{\sum (x_{3i} - \bar{x}_3)(x_{4i} - \bar{x}_4)}{\sqrt{\sum (x_{3i} - \bar{x}_3)^2 (x_{4i} - \bar{x}_4)^2}}$$

Then we can calculate $r_{13.2}$, $r_{14.3}$, $r_{12.3}$, $r_{24.3}$ and $r_{14.23}$ as.

$$r_{13.2} = \frac{r_{13} - r_{12} r_{23}}{\sqrt{(1 - r_{12}^2)}\sqrt{(1 - r_{23}^2)}}$$

$$r_{14.3} = \frac{r_{14} - r_{13} r_{34}}{\sqrt{(1 - r_{13}^2)}\sqrt{(1 - r_{34}^2)}}$$

$$r_{12.3} = \frac{r_{12} - r_{13} r_{23}}{\sqrt{(1 - r_{13}^2)}\sqrt{(1 - r_{23}^2)}}$$

$$r_{24.3} = \frac{r_{24} - r_{23} r_{34}}{\sqrt{(1 - r_{23}^2)}\sqrt{(1 - r_{34}^2)}}$$

And $$r_{14.23} = \frac{r_{14.3} - r_{12.3} r_{24.3}}{\sqrt{(1 - r_{12.3}^2)}\sqrt{(1 - r_{24.3}^2)}}$$

Substituting these values in Eq. (2.4.1) we can calculate the required coefficient of determination.

The following table (Table 2.1) represents the list of the stations considered along with the starting year and the years when data was not available. In table 2.2 the value of the correlation coefficients, in different significance level along with the number of years in which data was available, for different stations are tabulated.

First of all the raw data, collected from BMD, has been processed to obtain monthly and seasonal average of them. Also the standard deviation in terms of months and seasons have been computed. Using the processed data the correlation coefficients have been computed.

We have considered 30 stations all over Bangladesh. The computations are made station wise. These data are been plotted over the Bangladesh map, indicating the stations also, and interpolations have been done.

Table 2.1 Starting year and unavailability of data of different meteorological parameters used for different stations:

Station Name	Starting year	Data unavailable year	Station Name	Starting year	Data unavailable years
Dhaka	1953	1974	Ishwardy	1961	1967, 1968, 1969, 1980
Mymensing	1950	1991	Bogra	1948	1966, 1967, 1968
Tangail	1987		Rangpur	1957	1968, 1974, 1999
Faridpur	1948		Dinajpur	1948	1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980
Madaripur	1977	1979	Khulna	1948	1956, 1967, 1968, 1975
Chittagong	1949		Satkhira	1948	1955
Sandip	1966	1975	Jessore	1949	1965, 1966, 1967, 1968, 1978
Sitakundu	1977		Barisal	1949	1952, 1955
Rangamati	1957	1967, 1968	Patuakhali	1973	1974, 1980
Comilla	1948	1963, 1967, 1968, 1978	Khepupara	1974	
Chandpur	1966	1971, 1972, 1978, 1980, 1997, 1998	Bhola	1966	
Maizdy Court	1951	1976, 1977	Rajshahi	1964	1969, 1970
Feni	1974		Teknaf	1977	
Hatiya	1966	1972, 1981, 1995, 1996, 1967, 1998	Sylhet	1957	1973
Cox's Bazar	1948		Srimongal	1948	1960, 1961, 1981

Table 2.2 Value of correlation coefficient in different significance level for different stations:

Name of station	No. of Years	95% level	99% level
Dhaka	47	≥ 0.24	≥ 0.34
Mymensing	50	≥ 0.24	≥ 0.33
Bogra	50	≥ 0.24	≥ 0.33
Srimongal	50	≥ 0.24	≥ 0.33
Tangail	14	≥ 0.46	≥ 0.61
Faridpur	53	≥ 0.23	≥ 0.32
Cox's Bazar	53	≥ 0.23	≥ 0.32
Madaripur	23	≥ 0.35	≥ 0.48
Chittagong	52	≥ 0.23	≥ 0.32
Sandip	34	≥ 0.29	≥ 0.39
Bhola	34	≥ 0.29	≥ 0.39
Sitakundu	24	≥ 0.35	≥ 0.48
Teknaf	24	≥ 0.35	≥ 0.48
Rangamati	42	≥ 0.26	≥ 0.36
Comilla	48	≥ 0.24	≥ 0.33
Maizdy Court	48	≥ 0.24	≥ 0.33
Khulna	48	≥ 0.24	≥ 0.33
Chandpur	35	≥ 0.29	≥ 0.39
Rajshahi	35	≥ 0.29	≥ 0.39
Feni	27	≥ 0.32	≥ 0.44
Hatiya	29	≥ 0.31	≥ 0.43
Sylhet	43	≥ 0.26	≥ 0.36
Ishwardy	40	≥ 0.25	≥ 0.37
Rangpur	41	≥ 0.25	≥ 0.37
Dinajpur	45	≥ 0.26	≥ 0.36
Satkhira	51	≥ 0.24	≥ 0.34
Jessore	47	≥ 0.24	≥ 0.34
Barisal	49	≥ 0.24	≥ 0.34
Patuakhali	25	≥ 0.34	≥ 0.46
Khepupara	26	≥ 0.33	≥ 0.45

CHAPTER III

Results & Discussion

3.1 Distribution of average Dry Bulb Temperature (DBT), Wet Bulb Temperature (WBT) and Rainfall of monsoon and post-monsoon season

In the following subsections distribution of average DBT, WBT and Rainfall in the monsoon and post-monsoon months have been discussed.

3.1.1 Distribution of average DBT of the months of June, July, August and September

June: The distribution of average DBT of the month of June all over Bangladesh is shown in Fig 3.1.1 (a). It is observed that in this month the temperature increases gradually from northeast to west and southwest. The observed lowest value of average DBT is 27.2^{0}C at Sylhet region and the highest value at Satkhira region is 29.4^{0}C. The average DBT has also increased from the southeast to westward direction of the country during the period of investigation.

July: The distribution of average DBT of July all over Bangladesh is shown in Fig 3.1.1 (b). From figure it is observed that the average DBT increases gradually from east to west. In the northeastern side of the country i.e. over Sylhet region the average DBT is 27.5^{0}C and the average DBT at Rangamati region is 27.3^{0}C. The average DBT of 28.5^{0}C is observed at Dinajpur and Rajshahi region. The highest value of average DBT 28.6^{0}C is observed at Madaripur and Satkhira region and the lowest value of average DBT is observed in the hill tract region and its value is 27.3^{0}C.

August: The distribution of average DBT of August all over Bangladesh is shown in Fig 3.1.1 (c). In this month if we exclude Madaripur and Tangail the average DBT increases gradually from southeast to northwest direction. 27.2^{0}C is the lowest and 28.9^{0}C is the highest value of average DBT and are found at Rangamati and Madaripur respectively. The difference of the average DBT between southeast to northwest is 1.5^{0}C. Except Madaripur linear increasing trend of average DBT is observed.

September: The distribution of average DBT of September all over Bangladesh is shown in Fig 3.1.1 (d). In this month the average DBT increases gradually from northeast to southwest direction except Madaripur. At Sylhet the average DBT of 27.3^{0}C is observed, which is the lowest value and at Madaripur the highest value of average DBT 28.8^{0}C is observed.

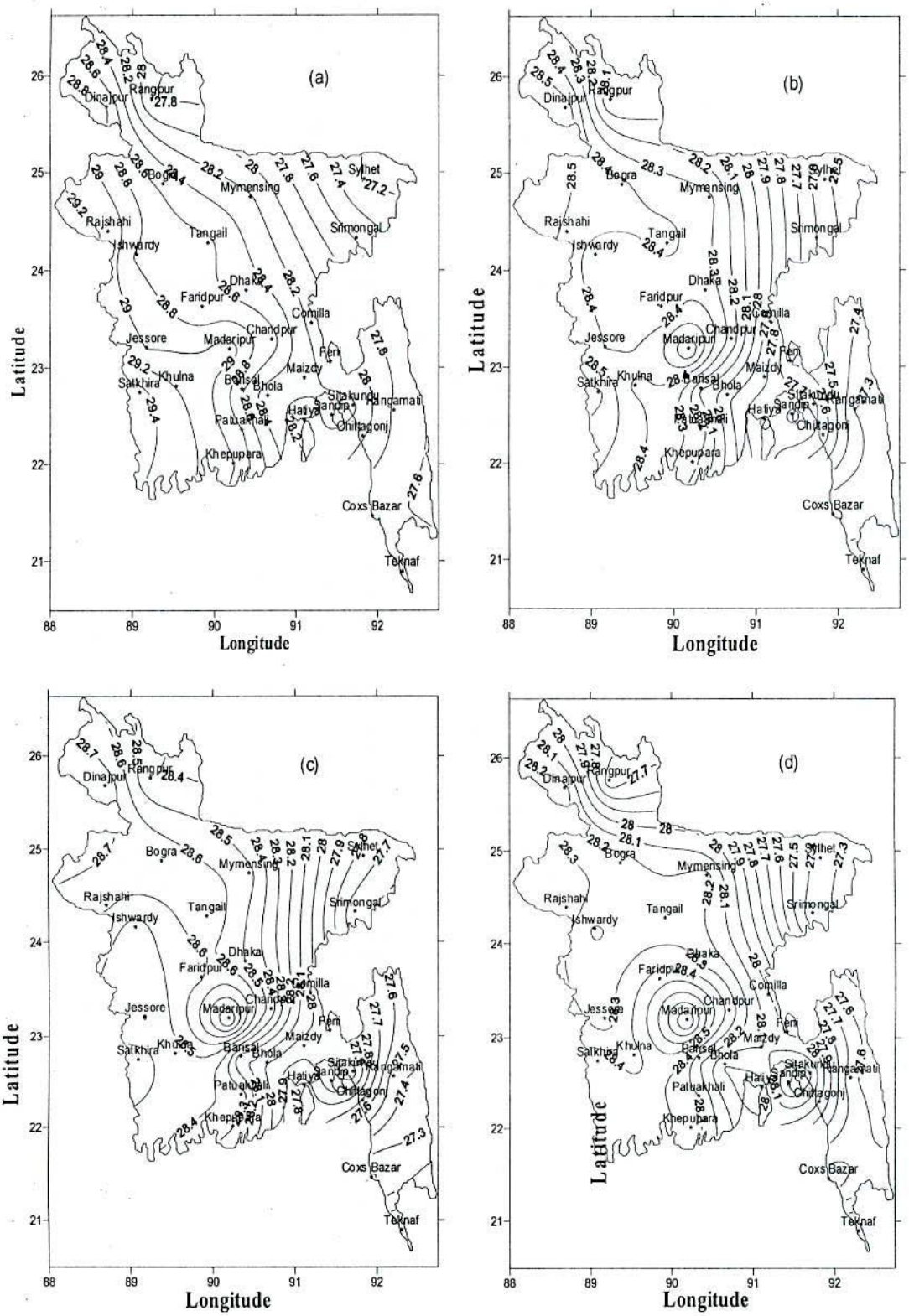


Fig 3.1.1(a-d): Average DBT for the months of June, July, August and September respectively

From the above discussion it is clear that the average DBT increases from northeast to southwest or from southeast to northwest direction during the monsoon months. Thus western side of the country is warmer then the eastern side in the monsoon period. It is also observed that the highest average DBT is observed over Madaripur region during the different months of monsoon season.

3.1.2 Distribution of average WBT of the months of June, July, August and September

June: The distribution of average WBT of the month of June all over Bangladesh is shown in Fig 3.1.2 (a). The figure shows that the average WBT increases gradually from northeast to southwest direction. The lowest value of average WBT 25.5^0C is observed at Sylhet and the highest 27.2^0C at Khulna, Sundarban and Khepupara region. The minimum average WBT is observed in the hilly region and maximum average WBT is observed in the Sundarban region.

July: The distribution of average WBT of July all over Bangladesh is shown in Fig 3.1.2 (b). From figure it is observed that the average WBT increases gradually from east to west. The lowest average WBT 25.5^0C is observed in the southeastern hilly region. The highest average WBT 26.8^0C is observed at Rajshahi, Madaripur, Khulna, Satkhira and Sundarban region.

August: The distribution of average WBT of August all over Bangladesh is shown in Fig 3.1.2 (c). In this month the average WBT increases gradually from south east to northwest direction. The lowest value of the average WBT 25.6^0C is observed at Rangamati and the highest value of average WBT 26.9^0C is observed at Madaripur.

September: The distribution of average WBT of September all over Bangladesh is shown in Fig 3.1.2 (d). From figure it is observed that the average WBT increases gradually from east to southwest direction. The lowest average WBT 25.6^0C is observed at Sylhet and southeast hilly region and the highest average WBT 26.6^0C is observed at Madaripur, Barisal and Khepupara region. The variation of average WBT within the country is that only 1^0C.

From the above discussion it can be summarized that the average WBT increases mainly from east to west. Also the average WBT all over the country is more or less homogeneous in the month of September.

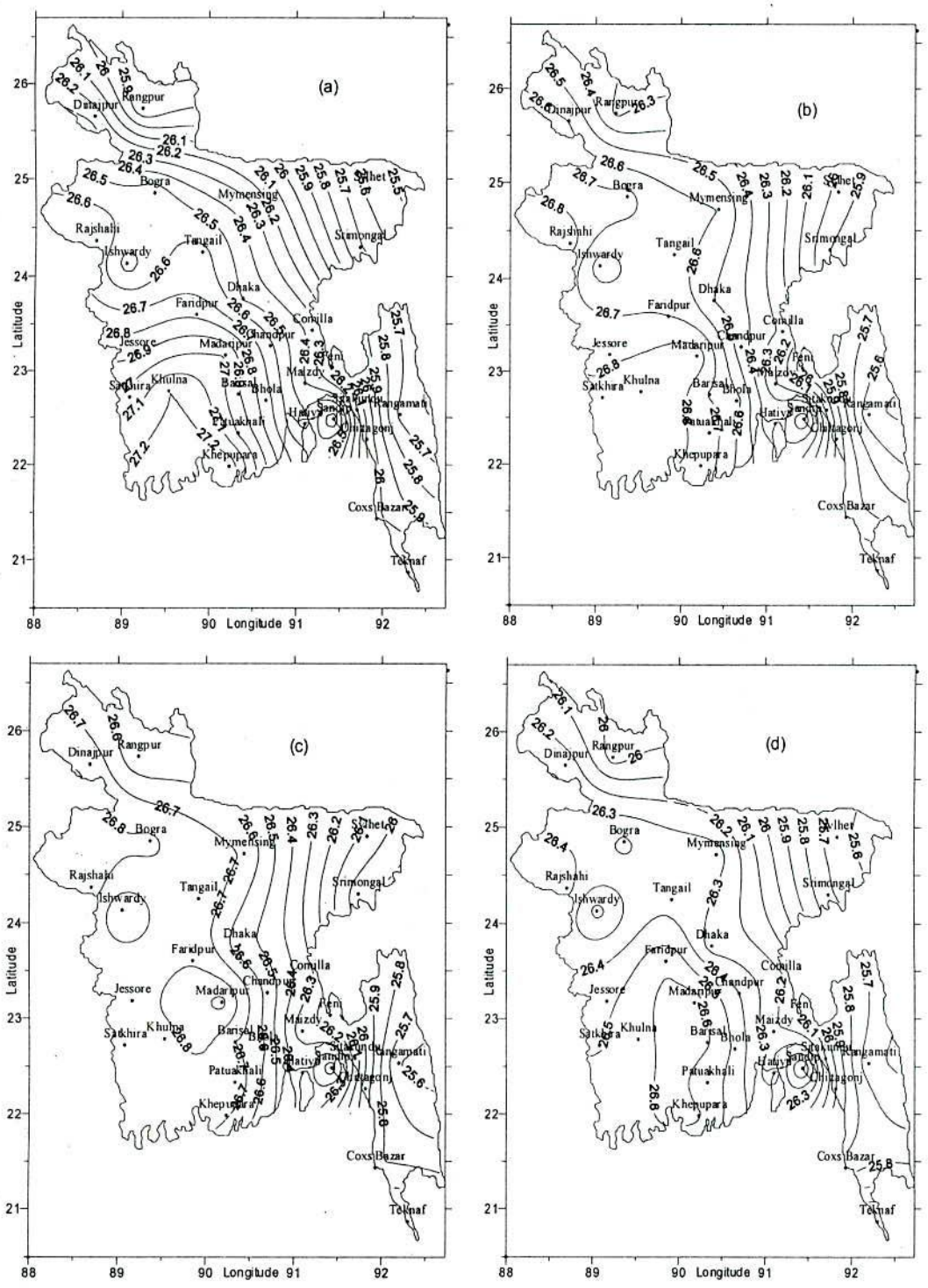


Fig 3.1.2(a-d): Average WBT for the months of June, July, August and September respectively

3.1.3 Distribution of average rainfall of the months of June, July, August and September

June: Fig 3.1.3 (a) represents the distribution of average rainfall of the month of June all over Bangladesh. In this month the average rainfall is very high toward the northeast and extreme southern part of the country i.e. Sylhet and Cox's Bazar-Teknaf region. The amount of this month's average rainfall at Sylhet is 800 mm and at Teknaf it is more than 900 mm. The average rainfall is gradually decreasing from Teknaf towards Rangamati region and from Sylhet towards Rajshahi-Jessore-Satkhira region. The minimum amount of average rainfall is observed in the west part of the country i.e. Rajshahi, Jessore and Satkhira region and it is about 300 mm. Around the central region of the country the amount average rainfall of this month is 350-400 mm.

July: The distribution of average rainfall of the month of July all over Bangladesh is shown in Fig 3.1.3 (b). The distribution pattern of the average rainfall of this month is as like as that of June. Like June the average rainfall is very high in Cox's Bazar-Teknaf region. The average rainfall gradually decreases from Teknaf towards Rangamati. The average rainfall also gradually decreases from Sylhet towards west direction. The maximum average rainfall is observed at Teknaf and is more than 1000 mm and the minimum amount of average rainfall is observed at Khulna, Satkhira, Jessore, Faridpur, Rajshahi, Ishwardy, and Tangail region. At the central region of the country the average rainfall lies between 350-400 mm. The area of minimum average rainfall has extended in the eastward direction in comparison to that of June and lies in the west-central region.

August: The distribution of rainfall of the month of August all over Bangladesh is shown in Fig 3.1.3 (c). In this month the average rainfall is again high towards the northeast and extreme south of the country. The amount of the average rainfall at Sylhet, Hatiya and Chittagong is 600 mm. The maximum amount of average rainfall is observed at Teknaf, which is more than 800 mm. The average rainfall decreases gradually from Teknaf towards Rangamati and from Sandip and Sylhet to west-central region of the country. The minimum amount of average rainfall is observed towards the west central part of the country and is about 300 mm. 300-400 mm of rainfall is observed in the central region of the country.

September: The distribution of average rainfall of the month of September all over Bangladesh is shown in Fig 3.1.3 (d). In this month the average rainfall increases towards

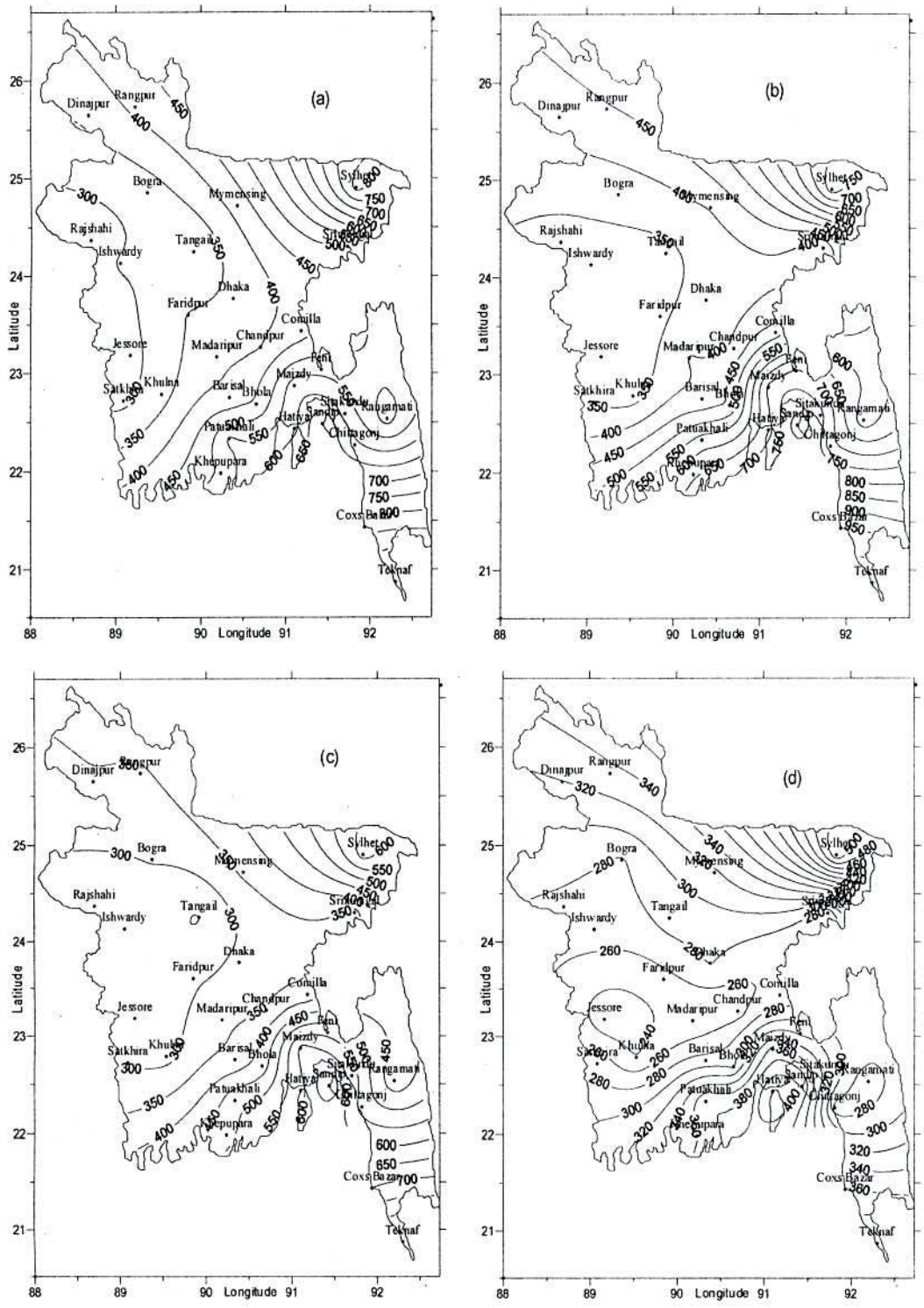


Fig 3.1.3(a-d): Average rainfall for the months of June, July, August and September respectively

the northeast of the country. The maximum 500mm of average rainfall is observed at Sylhet. The amount of rainfall observed at Hatiya is 400 mm. The average rainfall gradually decreases towards the west-central region of the country from both east corners. The minimum amount of average rainfall is observed that Jessore region and its value is 220 mm. 250-300 mm of rainfall occurred in the central region of the country.

From the above analysis it is found that the maximum amount of average rainfall is observed at Teknaf, Cox's Bazar and Sylhet region and decreases gradually towards west. The minimum amount of average rainfall is observed in the west central belt of the country in the Satkhira, Khulna, Faridpur and Rajshahi belt. It is also observed that the average maximum rainfall occurs in the month of July over Teknaf region. In the context of the whole monsoon season Jessore and its surroundings get the minimum amount of rain.

3.1.4 Distribution of average rainfall of the months of October and November

October: Figure 3.1.4 (a) shows the distribution of average rainfall of the month of October all over Bangladesh. From the figure it is observed that significant amount of average rainfall occurred in the northeast, southeast and extreme southern parts of the country. The amount of average rainfall at Sylhet is 210 mm and at Cox's Bazar is 230 mm. The highest amount of average rainfall is observed at Sandip and its value is 240 mm. The lowest amount of average rainfall is observed around the Rajshahi region and it is about 110 mm at Ishwardy 130-170 mm of rainfall occurred in this month around the central region of the country.

November: The distribution of average rainfall of the month of November all over Bangladesh is shown in Fig 3.1.4 (b). Little amounts of rainfall is observed in this month all over the country. The average rainfall of the month is comparatively much lower than that of October. The maximum amount of average rainfall is observed at Patuakhali, Bhola and Cox's Bazar and its value is around 70 mm. The rainfall gradually decreases from Cox's Bazar towards Rangamati and from south to northwestern direction. The minimum amount of average rainfall is observed at Rangpur-Dinajpur region and it is less than 10 mm. Average 80 mm of rainfall is observed at Bhola, which is the highest amount of this month.

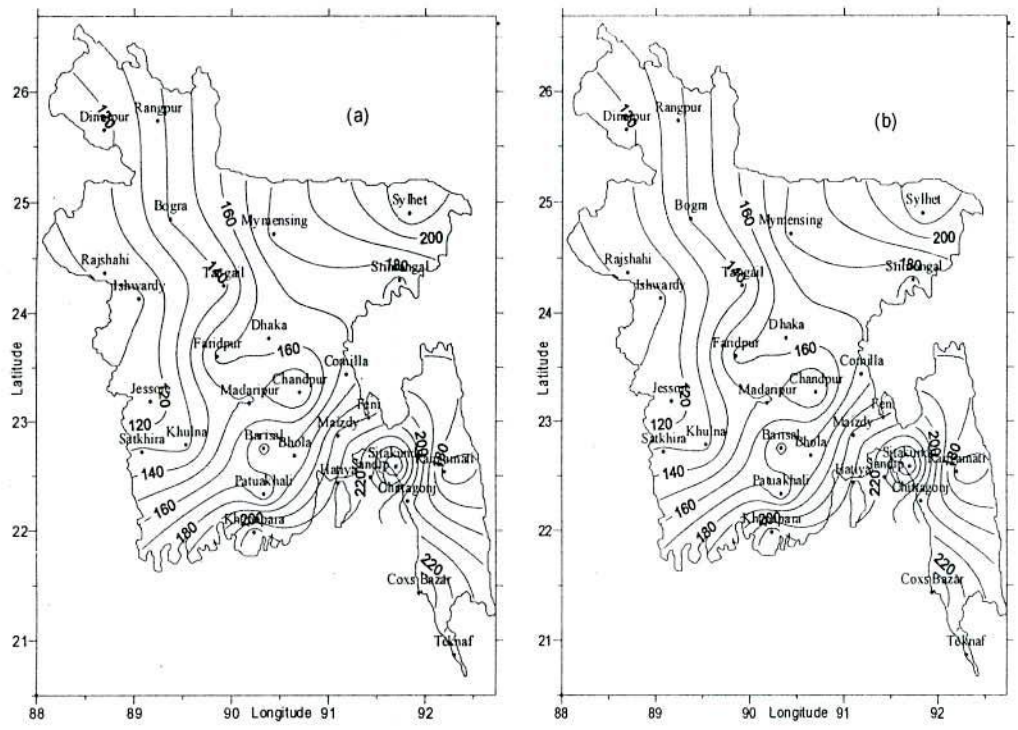


Fig 3.1.4(a-b): Average rainfall for the months of October and November respectively.

3.1.5 Distribution of average DBT, WBT and rainfall of Monsoon and rainfall of Post-monsoon

DBT of monsoon months: The distribution of average DBT of the months of monsoon all over Bangladesh is shown in Fig 3.1.5 (a). In this season the average DBT increases gradually form the east to west of the country. The lowest value of average DBT is observed 27.4^{0}C at Sylhet and the highest value of average DBT is observed 28.8^{0}C at Madaripur region.

WBT of monsoon months: The distribution of average WBT of monsoon all over Bangladesh as shown in Fig 3.1.5 (b). In this season the average WBT increases gradually form the northeast to west and southwest region of the country. The lowest value of average WBT 25.6^{0}C is observed at Rangamati and the highest value 26.8^{0}C is observed at Satkhira-Khulna-Madaripur-Khepupara region.

Rainfall of Monsoon months: The distribution of average rainfall in the months of monsoon all over Bangladesh is shown in Fig 3.1.5 (c). In this season the average rainfall is very high towards the northeast and extreme southern part of the country. The amount of average rainfall in the months of this season at Cox's Bazar is 700 mm, which is the maximum, and that at Sylhet is 650 mm. The average rainfall gradually decreases towards the west central part of the country. The minimum 300 mm of average rainfall is observed over the Rajshahi-Ishwardy-Tangail-Jessore-Khulna-Satkhira region. 300-400 mm of average rainfall is observed in the central region of the country.

Rainfall of Post-monsoon: The distribution of average rainfall in the months of Post-monsoon season all over Bangladesh is shown in Fig 3.1.5 (d). In this season the average rainfall is high towards the extreme southern and southeastern parts of the country i.e. Cox's Bazar and Hatiya, Sandip and Khepupara region. The highest 150 mm of average rainfall is observed at Cox's Bazar region. The rainfall gradually decreases from Teknaf to Rangamati and from southeastern part to northwestern part of the country. About 65mm of rainfall is observed at Dinajpur, Rajshahi, Ishwardy region which is the minimum. 80 – 100 mm of average rainfall occurred in this season in the central region of the country.

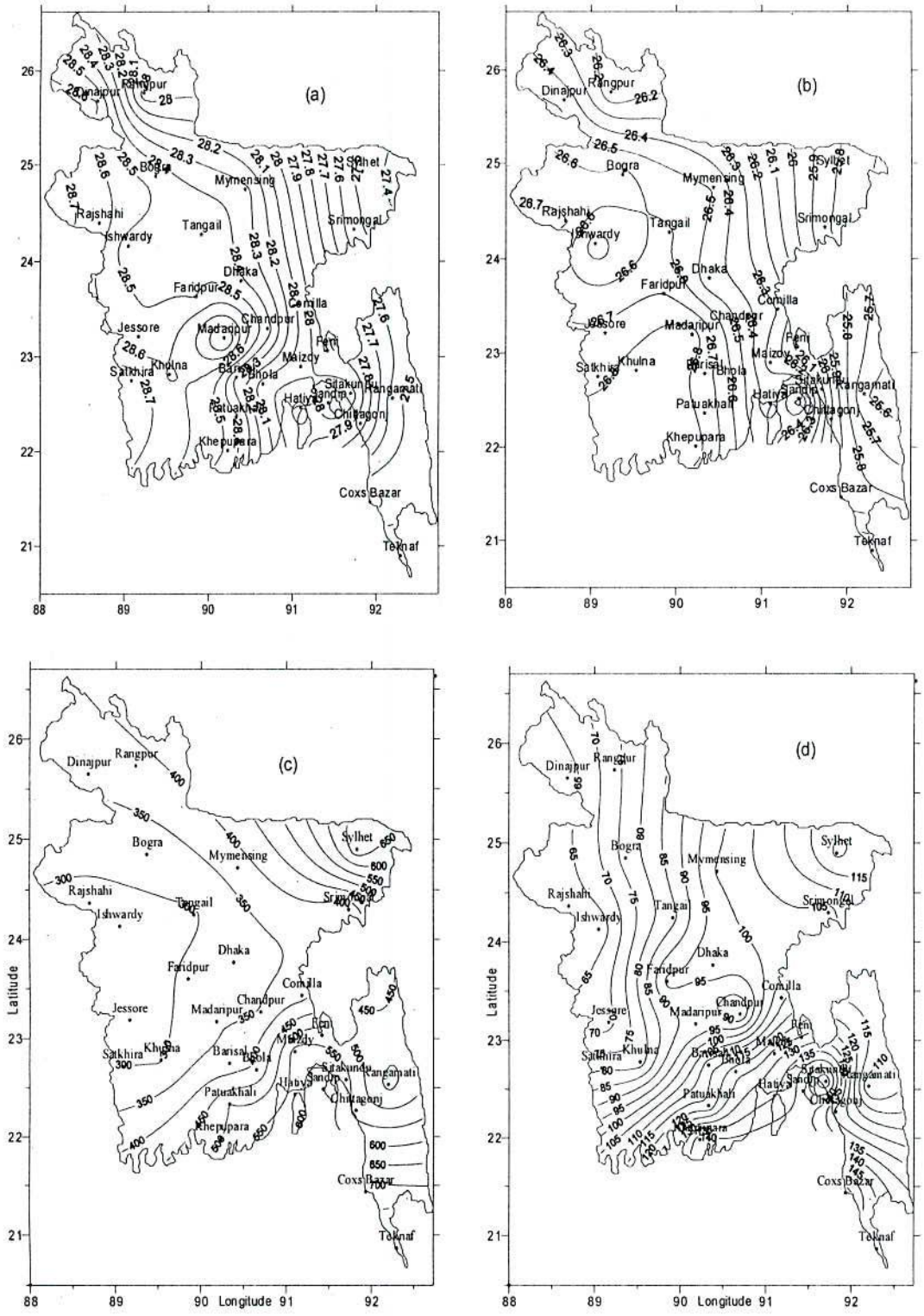


Fig 3.1.5(a-d): Average DBT, WBT, Rainfall of monsoon and rainfall of post-monsoon respectively

3.2 Distribution of Standard deviations (SD) of different meteorological parameters in the monsoon and Post-monsoon season

3.2.1 Distribution of SD of average DBT of the months of June, July, August and September

June: The distribution of SD of average DBT of the month of June all over Bangladesh is shown in Fig 3.2.1 (a). The SD of average DBT over the whole country lies between 0.6 to 0.7^{0}C except northwestern region. Its value at Rangpur is 1.5^{0}C which is the maximum. From figure it is also observed that the SD of average DBT is minimum over Khepupara, Hatiya and Rangamati region.

July: The distribution of SD of average DBT of the month of July all over Bangladesh is shown in Fig 3.2.1 (b). From the figure we observe that at the northwestern region of the country the SD of average DBT of this month is very high in comparison to the other regions. Over most of the regions the SD lies between 0.4^{0}C and 0.5^{0}C. At Rangpur the SD of average DBT is the highest and its value is more than 1.4^{0}C.

August: The distribution of SD of average DBT of the month of August all over Bangladesh is shown in Fig 3.2.1 (c). From figure we observe that at the northwestern part of the country the SD of average DBT is again comparatively high with respect to the other parts of the country. In almost all the regions the SD lies between 0.4 and 0.6^{0}C except Rangpur. At Rangpur the SD of average DBT is the highest and its value is 1.4^{0}C.

September: The distribution of SD of average DBT of the month of September all over Bangladesh is shown in Fig 3.2.1 (d). From figure we observe again that at the northwestern part of the country the SD of average DBT is comparatively very high in comparison to that of the other parts of the country. In almost all the regions of the country the SD lies between 0.45 to 0.55^{0}C except at Rangpur. At Rangpur the SD of average DBT is the highest and its value is 1.15^{0}C.

From the above discussions we may conclude that the SD of average DBT lies between 0.4 to 0.6^{0}C all over the country except northeast region during the months of June, July, August and September. At Rangpur the SD varies from 1.2 to 1.5^{0}C during these months.

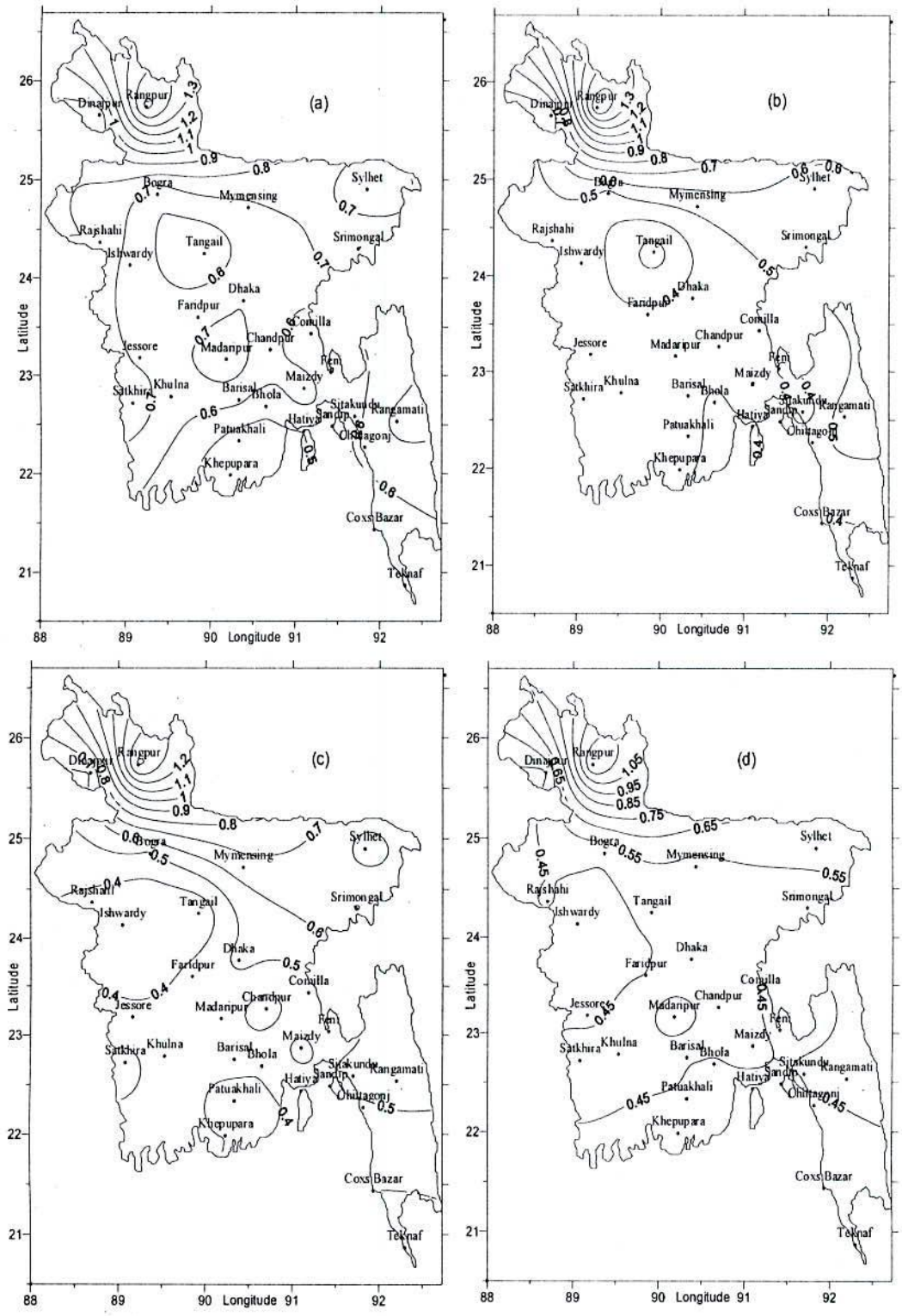


Fig 3.2.1(a-d): Standard deviation of DBT for the months of June, July, August and September respectively

3.2.2 Distribution of average SD of WBT of the months of June, July, August and September

June: The distribution of SD of average WBT of June all over Bangladesh is shown in Fig 3.2.2 (a). From the figure we observe that in the northwestern side of the country, i.e. in Rangpur region the SD of average WBT is comparatively high. Except that region in all others the SD lies between 0.4 and 0.5^0C and at Rangpur the SD of average WBT of June is 1.4^0C, which is the highest.

July: The distribution of SD of average WBT of July all over Bangladesh is shown in Fig 3.2.2 (b). From the figure we observe that in the northwestern side of the country, i.e. in Rangpur-Dinajpur region the SD of average WBT is much higher then that in the other region. Except that region in all other regions the SD lies between 0.3 and 0.4^0C. At Rangpur the SD of average WBT of July is 1.3^0C, which is the country highest. In the central region the SD of average WBT is almost constant and its value is 0.3^0C.

August: The distribution of SD of average WBT of August all over Bangladesh is shown in Fig 3.2.2 (c). This distribution pattern is as like as that of June and July i.e. in the Rangpur-Dinajpur region the SD of average WBT is much higher than that of the other regions. Except that regions the SD of average WBT is about 0.35^0C and its value at Rangpur is 1.25^0C

September: The distribution of SD of average WBT of September all over Bangladesh is shown in Fig 3.2.2 (d). This pattern is almost similar to that of August. At Rangpur the SD of average WBT is 1.05^0C and in other it lies between 0.35 and 0.45^0C. In the central region of the country the SD is almost constant and its value is 0.35^0C.

From the above analysis it is observed that the SD of average WBT in all over the country except northwestern region is low and it lies between 0.35 to 0.5^0C. In northwestern region that is much higher with respect to the rest of the country and its value lies between 1.15 to 1.4^0C.

3.2.3 Distribution of SD of average Rainfall of the months of June, July, August and September

June: The distribution of SD of average rainfall of June all over Bangladesh is shown in Fig 3.2.3 (a). Except around Sandip the distribution pattern is smooth and the

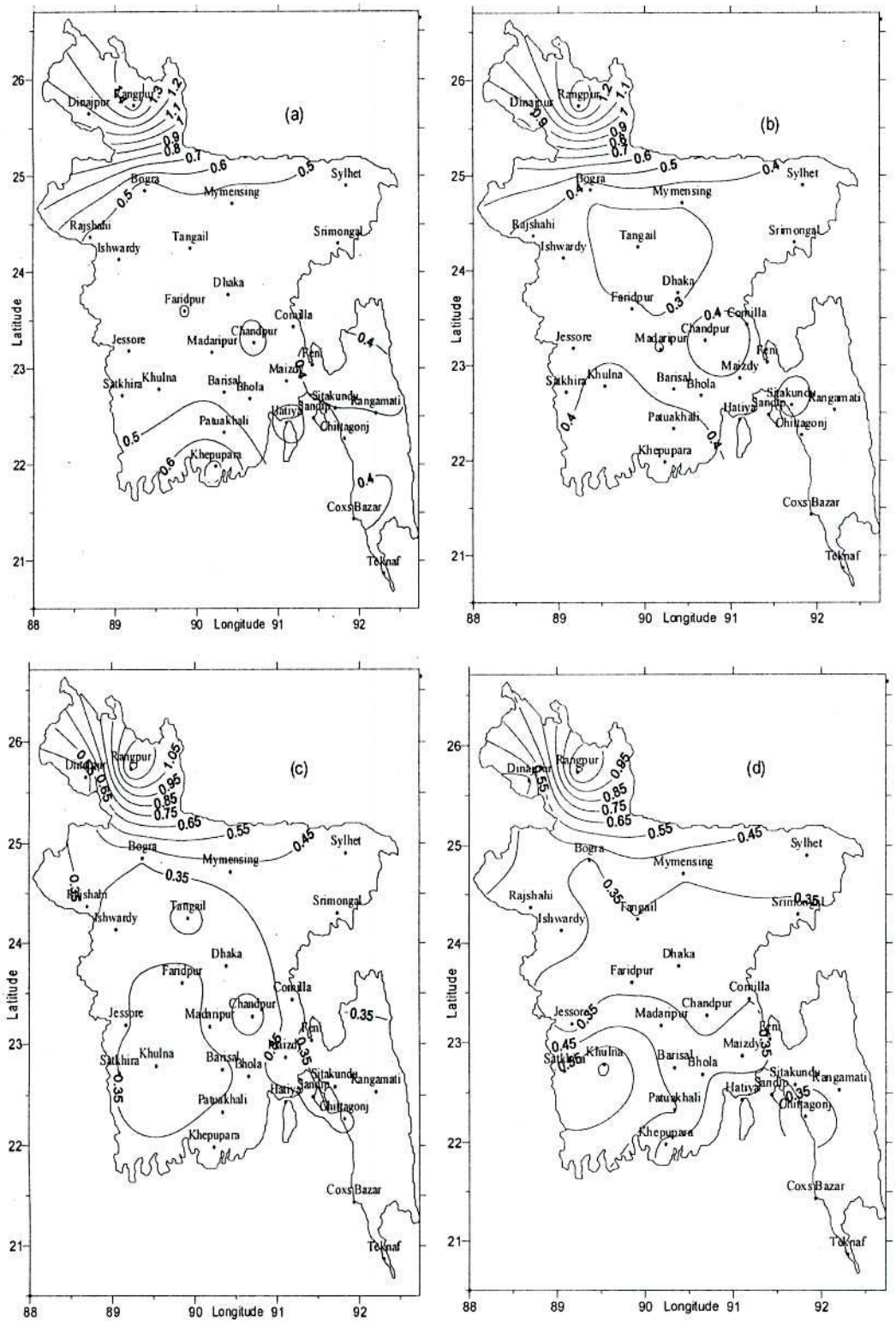


Fig 3.2.2(a-d): Standard deviation of WBT for the months of June, July, August and September respectively

SD increases from west central region towards east of the country. At Sandip it is about 425mm which is the highest and in the west central region it is about 150mm. The SD of average Rainfall in this month is almost 150 – 200 mm in the central region.

July: The distribution of SD of average rainfall of July all over Bangladesh is shown in Fig 3.2.3 (b). In this month the SD are comparatively very high at the northeastern and southeastern region of the country. The values of SD of average rainfall are more than 310 mm in the Chittagong-Cox's Bazar region and at Sylhet the value is more than 260 mm and gradually decreases towards the west central region of the country. Around Jessore the value is about 110mm which is the lowest. Most of the regions of the country have the value for SD in between 135 to 160 mm.

August: The distribution of SD of average rainfall of August all over Bangladesh is shown in Fig 3.2.3 (c). The value of SD of average rainfall towards the southeastern part of the country is higher than that of the rest. The SD of average rainfall is maximum at Sitakundu and is almost 290 mm. The minimum SD of average rainfall is observed over Tangail-Rajshahi-Ishwardy-Khulna-Satkhira region and its value is 115 mm. Over the most part of the country the SD of average rainfall lies between 115 to 165 mm.

September: The distribution of SD of average rainfall of September all over Bangladesh is shown in Fig 3.2.3 (d). In this month the value of SD in northeastern part of the country is comparatively high. At Sylhet it is more than 220 mm which is the maximum. Over Jessore, Madaripur and Rangamati the value is the minimum, which is just below 120 mm. Over most of the regions of the country the SD lies between 120 to 180 mm.

From this analysis we see that the average rainfall has the highest SD at Sandip-Sitakundu-Chittagong region in the months of June, July and August but this SD decreases as the season progress. In the month of September the SD is highest at Sylhet. Over most of the regions the SD lies between 120 – 160 mm throughout the season.

3.2.4. Distribution of SD of average rainfall of the months of October and November

October: The distribution of SD of rainfall of October all over Bangladesh is shown in Fig 3.2.4 (a). In this month the in almost all the regions the SD lies between 90

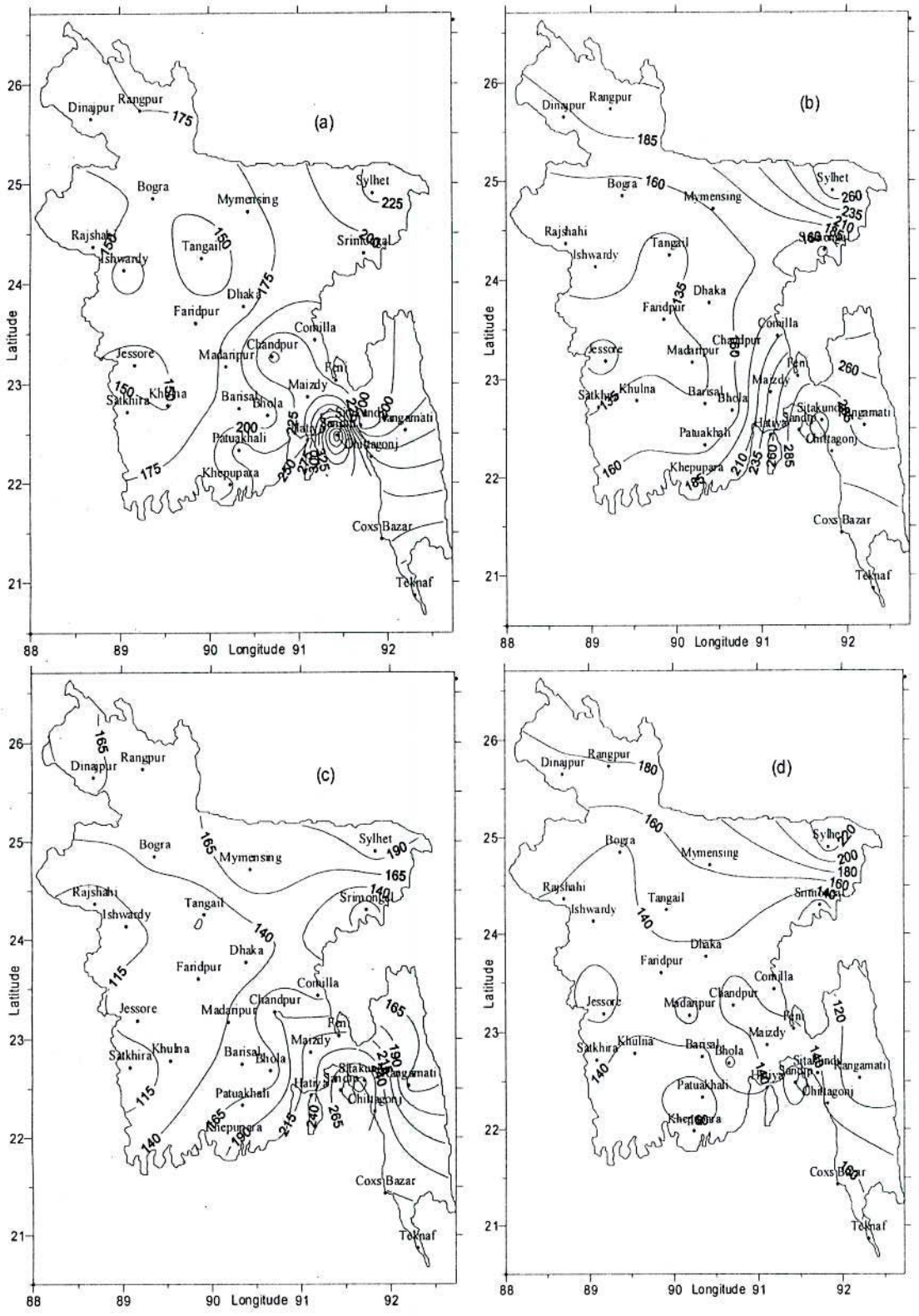


Fig 3.2.3(a-d): Standard deviation of Rainfall for the months of June, July, August and September respectively

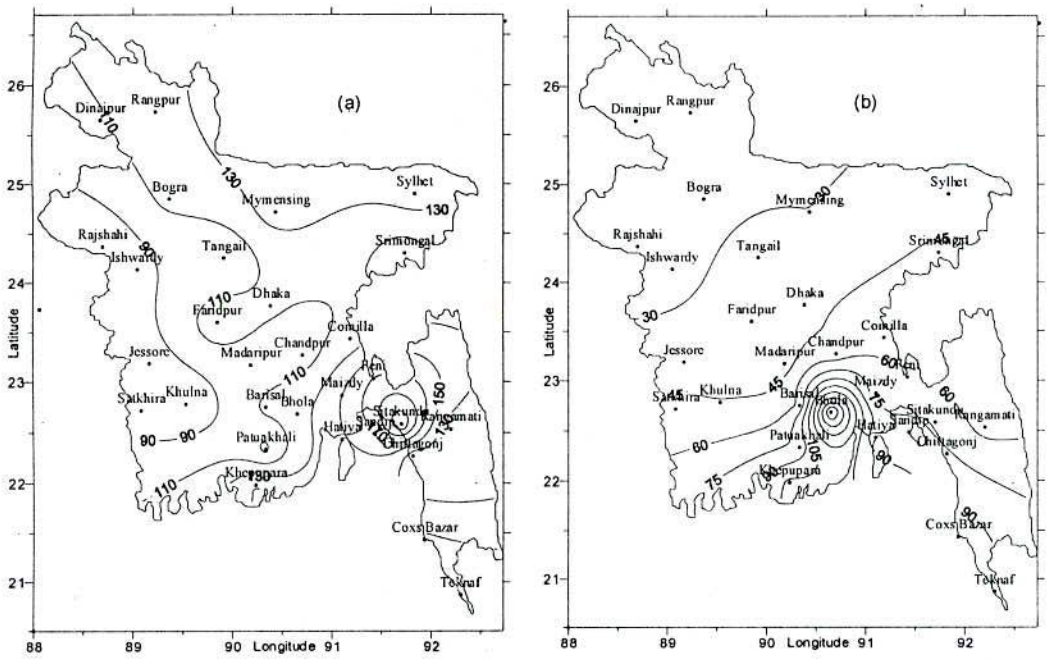


Fig 3.2.4(a-b): Standard deviation of rainfall for the months of October and November respectively

to 130 mm. The value of the SD at Sitakundu is greater than 200 mm. From the figure it is also observed that the SD is of minimum value towards the eastern side of the country and is 90 mm.

November: The distribution of SD of rainfall of November all over the country is shown in fig 3.2.4 (b). The observed SD of rainfall of November in the southern side of the country is significant. The SD of rainfall is of maximum value at Bhola and is almost 280 mm. The SD of rainfall is of minimum value in the central and northern regions of the country and the minimum value is between 30 to 45 mm.

3.2.5 Distribution of SD of DBT, WBT and Rainfall of Monsoon and Rainfall of Post-monsoon

DBT of Monsoon: The distribution of SD of average DBT of Monsoon all over Bangladesh is shown in Fig 3.2.5 (a). From the figure we observe that in the northwest part of the country the SD of average DBT of this season is comparatively high. In almost all the regions the SD lies between 0.3 to 0.4^{0}C except Rangpur. At Rangpur the SD of average DBT is highest and its value more than 1.2^{0}C.

WBT of Monsoon: The distribution of SD of average WBT of Monsoon all over Bangladesh is shown in Fig 3.2.5 (b). From the figure we observe that in the northwest side of the country, i.e. at Rangpur the SD of average WBT of this season is comparatively high. In almost all the regions the SD lies between 0.25 to 0.35^{0}C except Rangpur. At Rangpur the SD of average WBT is the highest and its value is more than 1.2^{0}C.

Rainfall of Monsoon: The distribution of SD of rainfall of monsoon all over Bangladesh is shown in Fig 3.2.5 (c). In this season the values of SD are comparatively high at the northeast and southeast part of the country. The maximum value of SD is 130 mm and is over Sylhet, Hatiya and Sitakundu regions. The SD is of lowest value in the regions where the rainfall is the minimum. The magnitude of this SD is 70 mm in Faridpur, Rajshahi, Jessore and Satkhira region.

Rainfall of Post-monsoon: The distribution of SD of rainfall of Post-monsoon all over Bangladesh is shown in Fig 3.2.5 (d). The SD of this season the SD is comparatively low with respect to the monsoon season. The maximum of SD is observed towards the south and southeast part of the country. This maximum SD is observed at Bhola and Sitakundu and is 105 mm. The minimum SD is 45mm and around is observed Satkhira, Khulna and Rajshahi region.

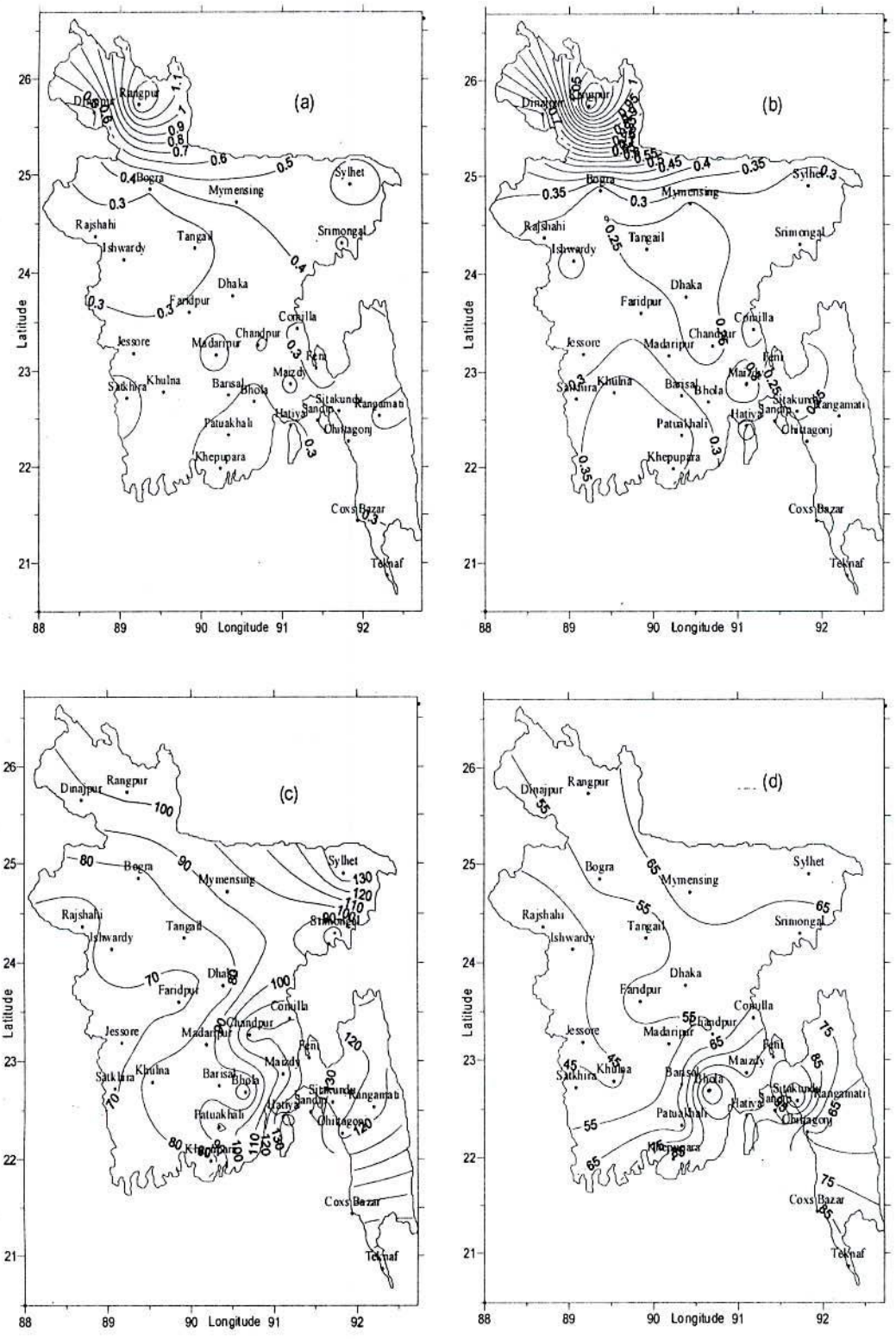


Fig 3.2.5(a-d): Standard deviation DBT, WBT and Rainfall of monsoon and rainfall of post-monsoon respectively

3.3 Correlation coefficients between October rainfall DBT, WBT and Rainfall of June, July, August and September

3.3.1 Distribution of CC between October rainfall and DBT of June, July, August and September

June: The distribution of CC between average DBT of June and the rainfall of October is shown in Fig 3.3.1 (a). The figure shows that the minimum value of CC is at Tangail and its value is -0.45. The negative CC is also observed at Satkhira and from Comilla towards Khepupara regions. The maximum positive CC is observed at Ishwardy region and its value is 0.25.

July: The distribution of CC between average DBT of July and the rainfall of October is shown in Fig 3.3.1 (b). From the distribution pattern we observe that the CC is positive all over country with few exceptions. The CC between the average DBT of July and rainfall of October is the maximum at Chandpur and its value is 0.30 and is significant at 95% level. The minimum of that is about –0.15 and is observed at Patuakhali.

August: The distribution of CC between average DBT of August and the rainfall of October is shown in Fig 3.3.1 (c). From the distribution pattern we observe that the CC is negative in the northeast, southwest and extreme south side of the country and the CC is positive in the northwest and southeast side of the country. The maximum positive and negative value of the CC is observed at Dinajpur and Patuakhali regions and the values are 0.30 and -0.25 respectively. The CC at Dinajpur is significant at 95% level.

September: The distribution of CC between average DBT of September and the rainfall of October all over Bangladesh is shown in Fig 3.3.1 (d). The figure reveals that except southeastern, northern, northeastern part of the country and over Ishwardy and Chandpur region the CC is negative. The maximum positive CC of about 0.3 over Chandpur region and highest negative CC of about –0.2 over Tangail-Faridpur and Khulna-Patuakhali is observed.

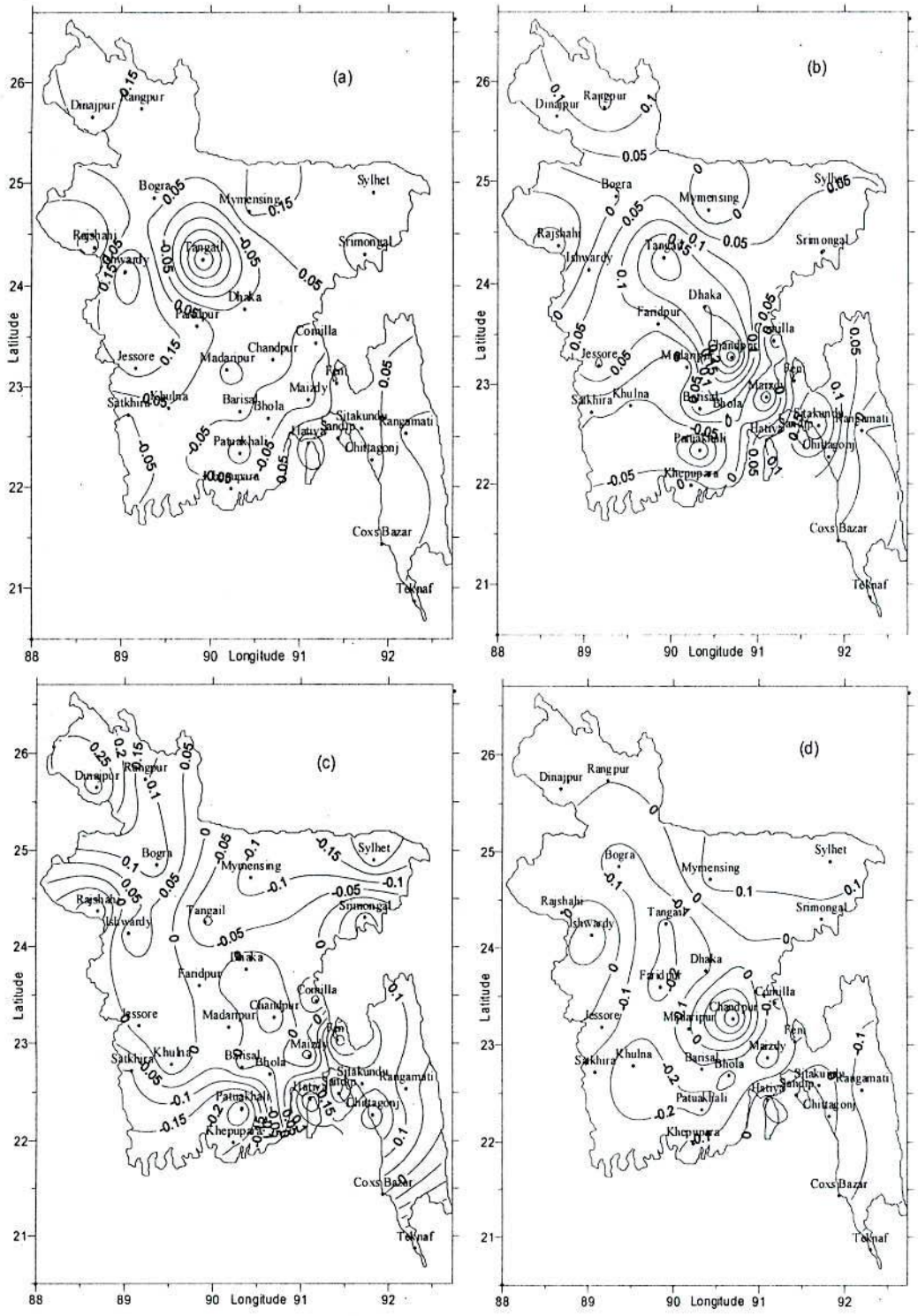


Fig 3.3.1(a-d): Correlation coefficients between October rainfall and DBT of June, July, August and September respectively

3.3.2 Distribution of CC between November rainfall and average DBT of June, July, August and September

June: The distribution of CC between the average DBT of June and the rainfall of November is shown in Fig 3.3.2 (a). The distribution pattern shows that over Rajshahi, Ishwardy, Jessore and Sylhet region the CC is negative. The maximum negative CC is observed at Rajshahi and Sylhet and its value is -0.2. The CC is positive in the maximum region of the country. The maximum positive CC is observed at Sitakundu and its value is about 0.4. From the analysis we can say that with the increase in the average DBT of June the rainfall of November will increase in Sitakundu region and that will decrease in Rajshahi and Sylhet regions.

July: The distribution of CC between average DBT of July and rainfall of November all over Bangladesh is shown in Fig 3.3.2 (b). From the distribution pattern we observe that the CC is negative in eastern side of the country except Sitakundu where the CC is positive and its value is about 0.15. On the other hand in the western side of the country the CC is positive except Jessore where it is negative and the value is about –0.1. The CC between the average DBT of July and the rainfall of November is the maximum over Rajshahi-Ishwardy region and its value is more than 0.15. The maximum negative CC is observed at Sylhet region and its value is less then -0.25. From the analysis we observe that if the average DBT of July increases then the rainfall of November will decrease in the eastern side and that will increase in the western side of the country and vise versa.

August: The distribution of CC between average DBT of August and rainfall of November all over Bangladesh is shown in Fig 3.3.2 (c). From the distribution pattern we observe that the CC is negative in the northern side of the country and the CC is positive in the southern side of the country except Bhola. The maximum positive CC is observed at Teknaf region and its values is 0.45. The highest negative CC is observed over Mymensing region and its value is –0.1. From the analysis we can say that the average DBT of August highly positive correlation with the rainfall of November in the extreme southern and southeastern side of the country.

September: The distribution of CC between average DBT of September and rainfall of November all over Bangladesh is shown in Fig 3.3.2 (d). From the distribution pattern we observed that the CC is negative in the northeast, west central and south

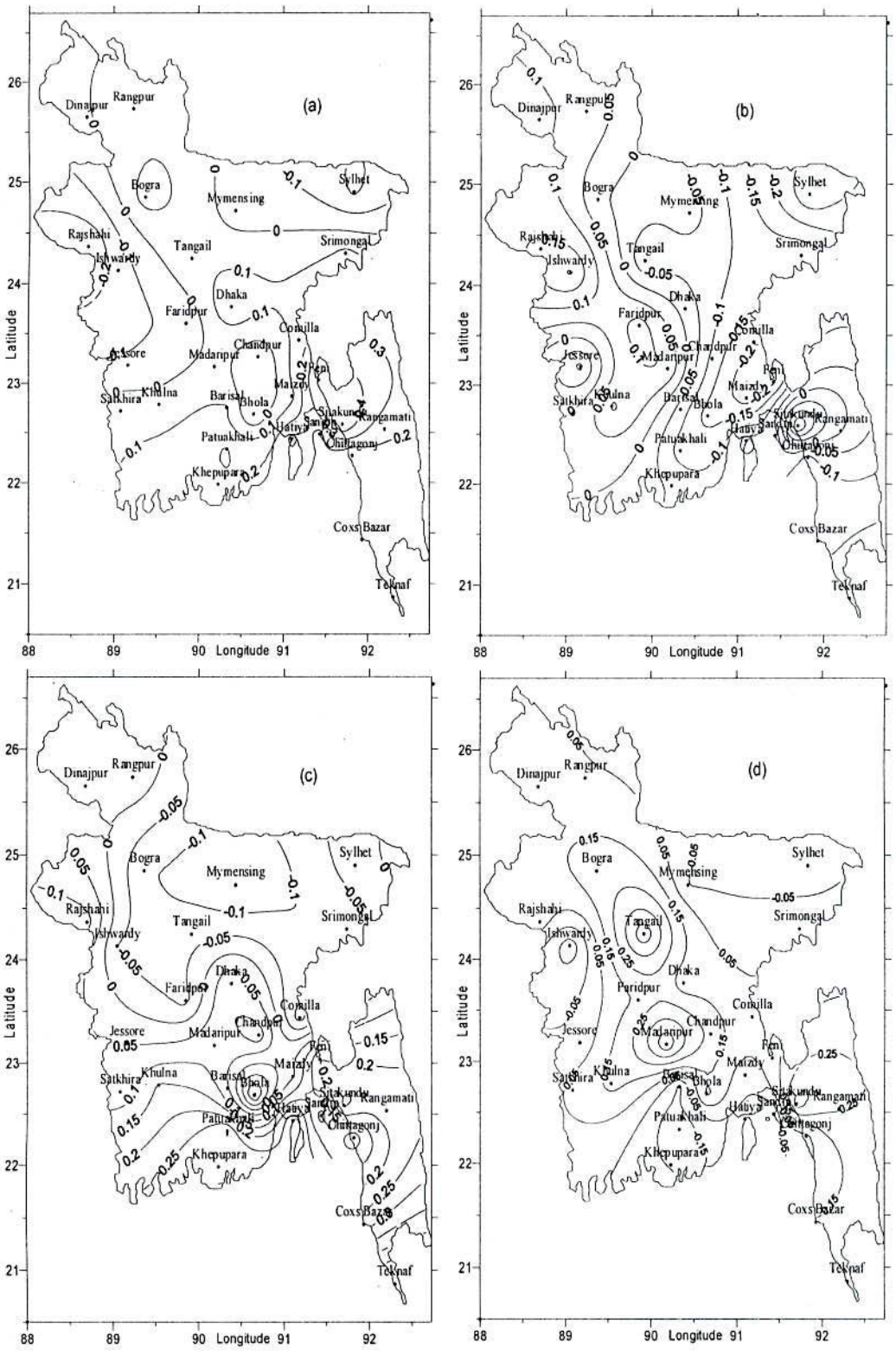


Fig 3.3.2(a-d): Correlation coefficients between November rainfall and DBT of June, July, August and September respectively

central side of the country and the CC is positive in the northwest, southeast and central region of the country. The maximum positive value of the CC is observed at Tangail and Madaripur and its value is 0.45. The maximum negative value of the CC is observed at Ishwardy and Khepupara region and its value is -0.15. From the analyses we may conclude that the average DBT of September and rainfall of November is positively correlated in most of the regions. The CC is significant 95% level at Tangail and Madaripur region.

From the above observations it is clear that the CC is negative in the northern side and positive in the southern side of the country except Bhola in August and negative in south and northeast side including Ishwardy and positive in central and southeastern region in September. The CC is positive in the south and southeastern side in June and negative in eastern side of the country except Sitakundu in July.

3.3.3 Distribution of CC between DBT of June, July, August and September and Post-monsoon rainfall

June: The distribution of CC between average DBT of June and average rainfall of Post-monsoon season all over Bangladesh is shown in Fig 3.3.3 (a). From the distribution pattern we observe that the CC is positive all over the country except Rajshahi, Tangail and Bhola region. The higher positive value of the CC are observed at Ishwardy, Hatiya and Sitakundu and are 0.30, 0.30 and 0.25 respectively. The maximum negative value of CC is observed at Tangail its value is -0.50. The CC is significant about 95% level at Tangail, Ishwardy and Hatiya.

July: The distribution of CC between average DBT of July and average rainfall of Post-monsoon all over Bangladesh is shown in Fig 3.3.3 (b). From the distribution pattern we observe that over the maximum region of the country the CC is positive except southern and southeastern side of the country where the CC is negative. The maximum negative and positive value of the CC is observed at Patuakhali and Sitakundu region and the values are -0.20 and 0.25 respectively.

August: The distribution of CC between average DBT of August and rainfall of Post-monsoon all over Bangladesh is shown in Fig 3.3.3 (c). From figure it is observed that except Bhola, Satkhira, Rajshahi and northeastern side of the country, where the CC is negative, the CC is positive. The maximum negative value of CC is observed at Sylhet and is -0.20. The maximum positive value of CC is observed at Dinajpur, Hatiya and

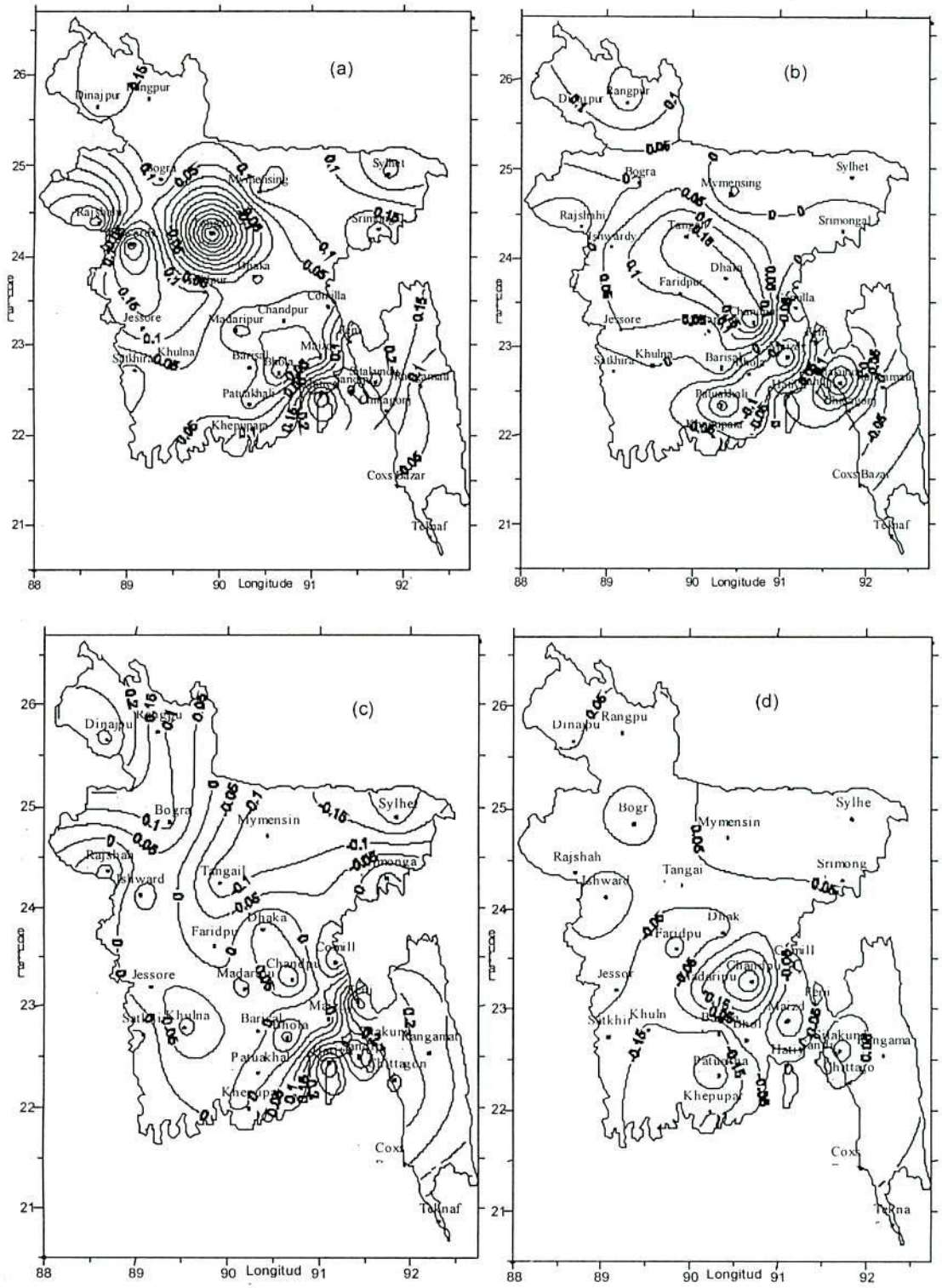


Fig 3.3.3(a-d): Correlation coefficients between DBT of June, July, August and September and Post-monsoon rainfall respectively

Sandwip region and is 0.3. From the analysis we can say that the average DBT of August and Post-monsoon rainfall is positively correlated i.e. any increase in the DBT of August will result some increase in the rainfall of Post-monsoon season. At Dinajpur, Sandwip and Hatiya the CC is significant at 95% level.

September: The distribution of CC between average DBT of September and average rainfall of Post-monsoon all over Bangladesh is shown in Fig 3.3.3 (d). The figure shows that the CC is negative in the southwestern and southern side of the country. The maximum positive and negative values of the CC are observed at Chandpur and Patuakhali region and are 0.35 and -0.25 respectively.

3.3.4 Distribution of CC between WBT of June, July, August and September and rainfall of October

June: The distribution of CC between average WBT of June and average rainfall of October all over Bangladesh is shown in Fig 3.3.4 (a). From the distribution pattern we observe that the CC is negative in Tangail, Feni and Khepupara region. The maximum positive and negative value of the CC is observed at Dinajpur and Tangail region and they are 0.25 and -0.4 respectively. From the analysis we can say that the average WBT of June and average rainfall of October are positively correlated, i.e. with the increase in the average WBT of June the average rainfall of October will increase.

July: The distribution of CC between average WBT of July and average rainfall of October all over Bangladesh is shown in Fig 3.3.4 (b). The figure shows that the CC is negative in the northeast, southeastern region and Tangail region of the country. The CC is positive in the northwest and central region of the country. The maximum positive value of the CC is observed at Chandpur region and its values is 0.30 and the maximum negative value of CC is observed at Tangail and Srimongal region and its value is -0.15.

August: The distribution of CC between average WBT of August and average rainfall of October all over Bangladesh is shown in Fig 3.3.4 (c). The distribution pattern shows that the CC is positive in the northwest, northeast and southeastern side of the country. It is also observed that CC is negative in the most of the regions of the country. The maximum positive and negative values of CC are observed at Dinajpur and Tangail region and are 0.35 and -0.40 respectively.

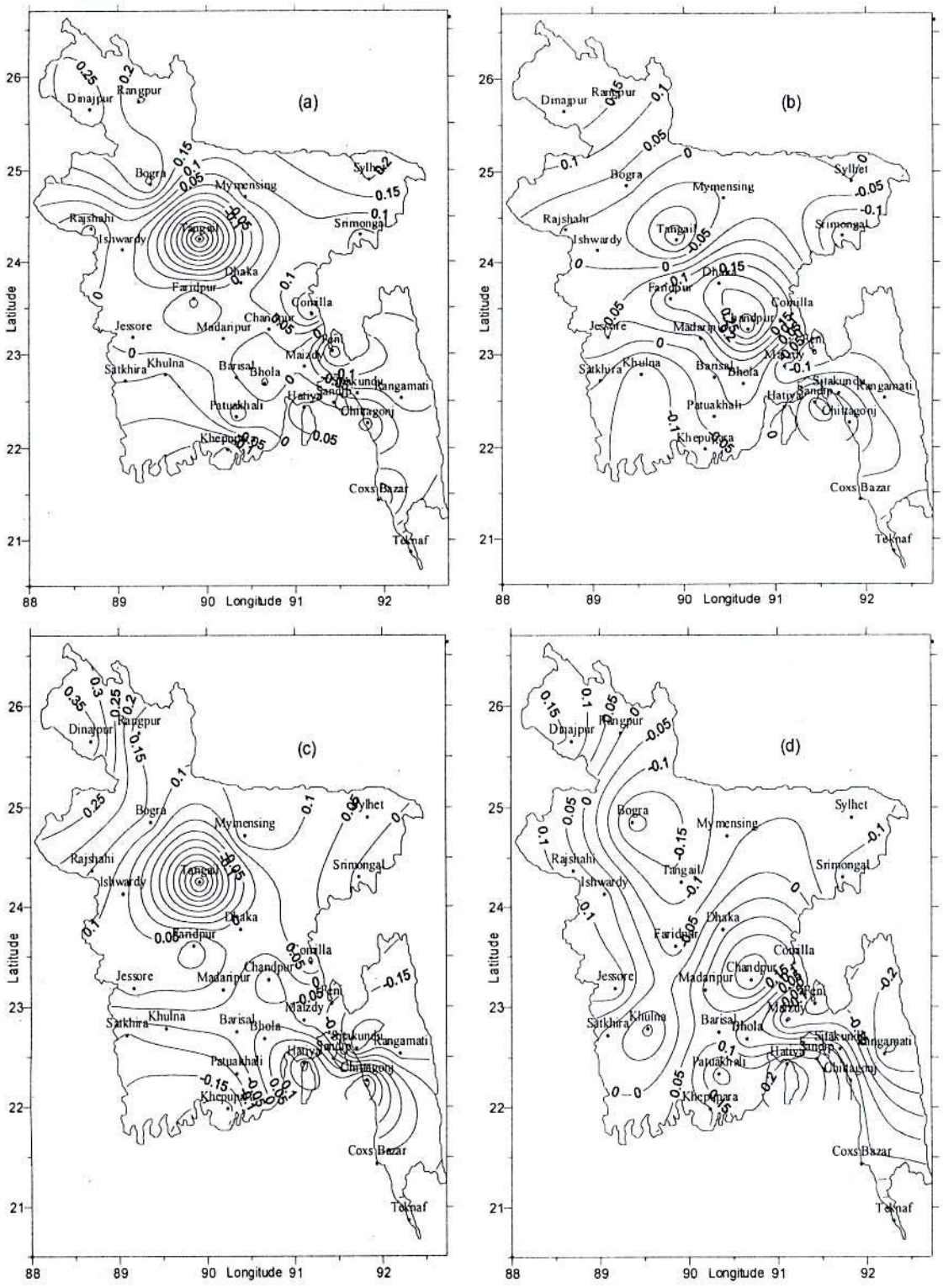


Fig 3.3.4(a-d): Correlation coefficients between WBT of June, July, August and September and rainfall of October respectively

September: The distribution of CC between average WBT of September and average rainfall of October all over Bangladesh is shown in Fig 3.3.4 (d). From the distribution pattern we observe that the CC is negative over Bogra, Tangail, Mymensing, Sylhet, Khulna and southeastern side of the country. The maximum positive value of CC is observed at Patuakhali, Chandpur and Hatiya and the maximum negative value of CC is observed at Bogra and Rangamati region and the values are 0.20 and -0.20 respectively.

3.3.5 Distribution of CC between WBT of June, July, August and September and rainfall of November

June: The distribution of CC between average WBT of June and average rainfall of November all over Bangladesh is shown in Fig 3.3.5 (a). From the distribution pattern we observe that the CC is positive all over the country except Bhola. The maximum positive value 0.55 of the CC is observed at Sitakundu. The negative value of the CC is observed at Bhola and is -0.15. From the analysis we may conclude that the WBT of June and rainfall of November are positively correlated i.e. with the increase the WBT of June the rainfall of November will also increase.

July: The distribution of CC between the average WBT of July and average rainfall of November all over Bangladesh is shown in Fig 3.3.5 (b). From the distribution pattern we observe that the CC is negative in the northeast, southeast and southern region of the country. The maximum positive and negative values of the CC are observed at Rajshahi, Madaripur and Teknaf and are 0.30, 0.25 and – 0.20 respectively.

August: The distribution of CC between the average WBT of August and the average rainfall of November all over Bangladesh is shown in Fig 3.3.5 (c). From the distribution pattern we observe that the CC is negative in the northeastern side of the country and in other region the CC is positive. The maximum positive and negative values of CC are observed at Sitakundu and Sylhet region and are 0.50 and –0.20 respectively. From the analysis we can say that the WBT of August and the rainfall of November are the positively correlated over maximum regions of the country.

September: The distribution of CC between the average WBT of September and the average rainfall of November all over the country is shown in Fig 3.3.5 (d). From the distribution pattern it is observed that the CC is positive all over the country. The higher positive values of CC are observed at Madaripur and Tangail region and are 0.50 and 0.40 respectively. From the analysis we can say that the rainfall of November will increase if the average WBT of September increases.

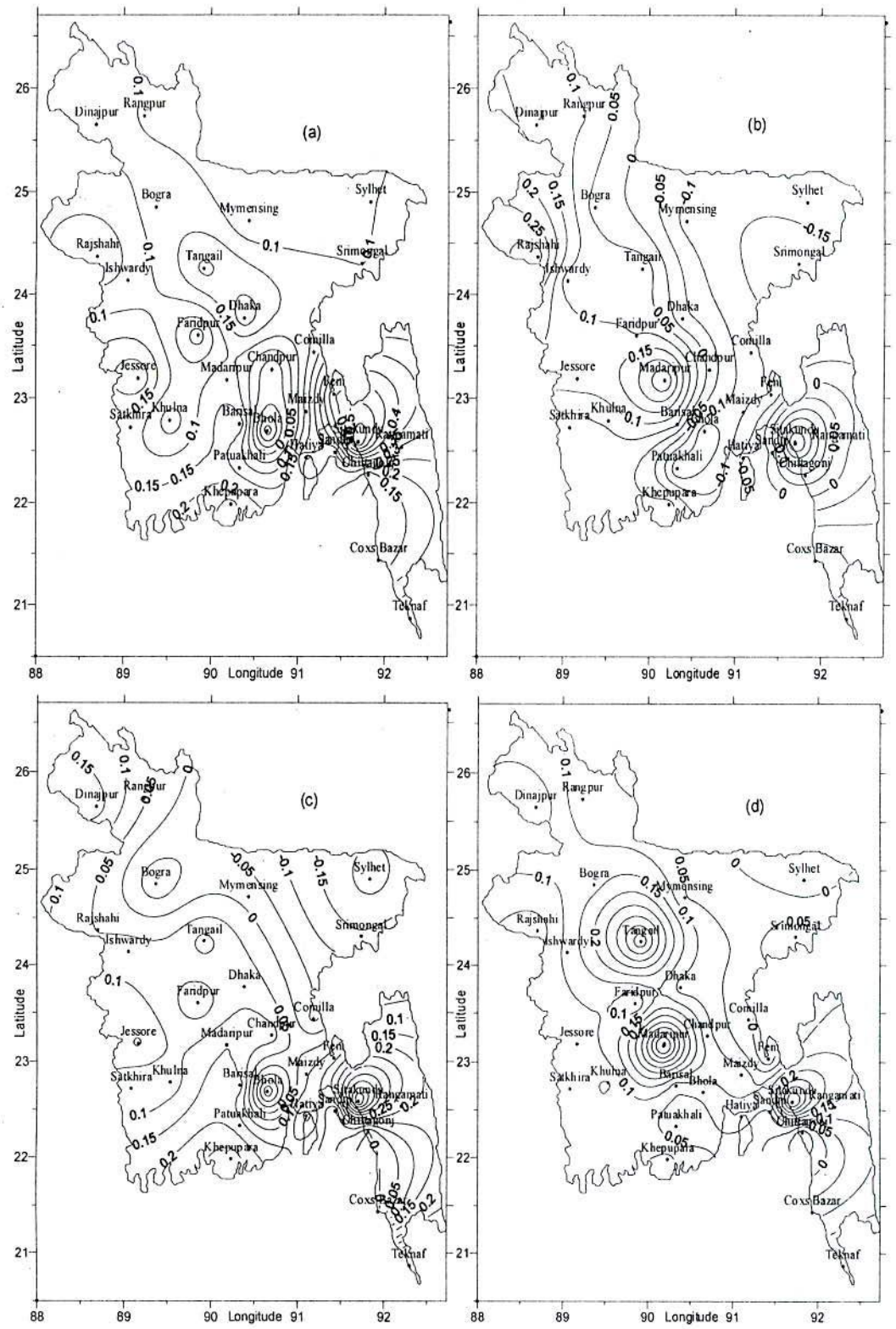


Fig 3.3.5(a-d): Correlation coefficients between WBT of June, July, August and September and rainfall of November respectively

3.3.6 Distribution of CC between WBT of June, July, August and September and Post-monsoon rainfall

June: The distribution of CC between the average WBT of June and the average rainfall of Post-monsoon all over Bangladesh is shown in Fig 3.3.6 (a). From the distribution pattern we observe that the CC is positive all over the country except Tangail. The maximum negative and the positive values of the CC are observed at Tangail and Dinajpur and are -0.35 and 0.25 respectively. From the analysis we can say that the rainfall of Post-monsoon season will increase if the WBT of June decreases over Tangail and increases all other regions.

July: The distribution of CC between the average WBT of July and the average rainfall of Post-monsoon season all over Bangladesh is shown in Fig 3.3.6 (b). From the distribution pattern we observe that the CC is negative in the northeast, southeast and southern region of the country. The positive value of CC is observed in the central and northwestern region of the country. The maximum positive and negative values of the CC are observed at Chandpur and Srimongal region and are 0.25 and – 0.20 respectively.

August: The distribution CC between the average WBT of August and the average rainfall of Post-monsoon season all over Bangladesh is shown in Fig 3.3.6 (c). From the distribution pattern we observe that the CC is positive all over the country except Srimongal, Sitakundu, Tangail and Sundarbon region. The maximum positive and negative values of the CC are observed at Dinajpur and Tangail region and are 0.40 and -0.35 respectively. From the analysis we can say that the average rainfall of Post-monsoon season will increase in the northwestern side of the country with the increases of WBT in August.

September: The distribution of CC between the average WBT of September and the average rainfall of Post-monsoon season all over the country is shown in Fig 3.3.6 (d). From the distribution pattern it is observed the CC is positive in the western and eastern side of the country. The maximum positive value of the CC is observed at Madaripur and Sandwip region and is 0.30.

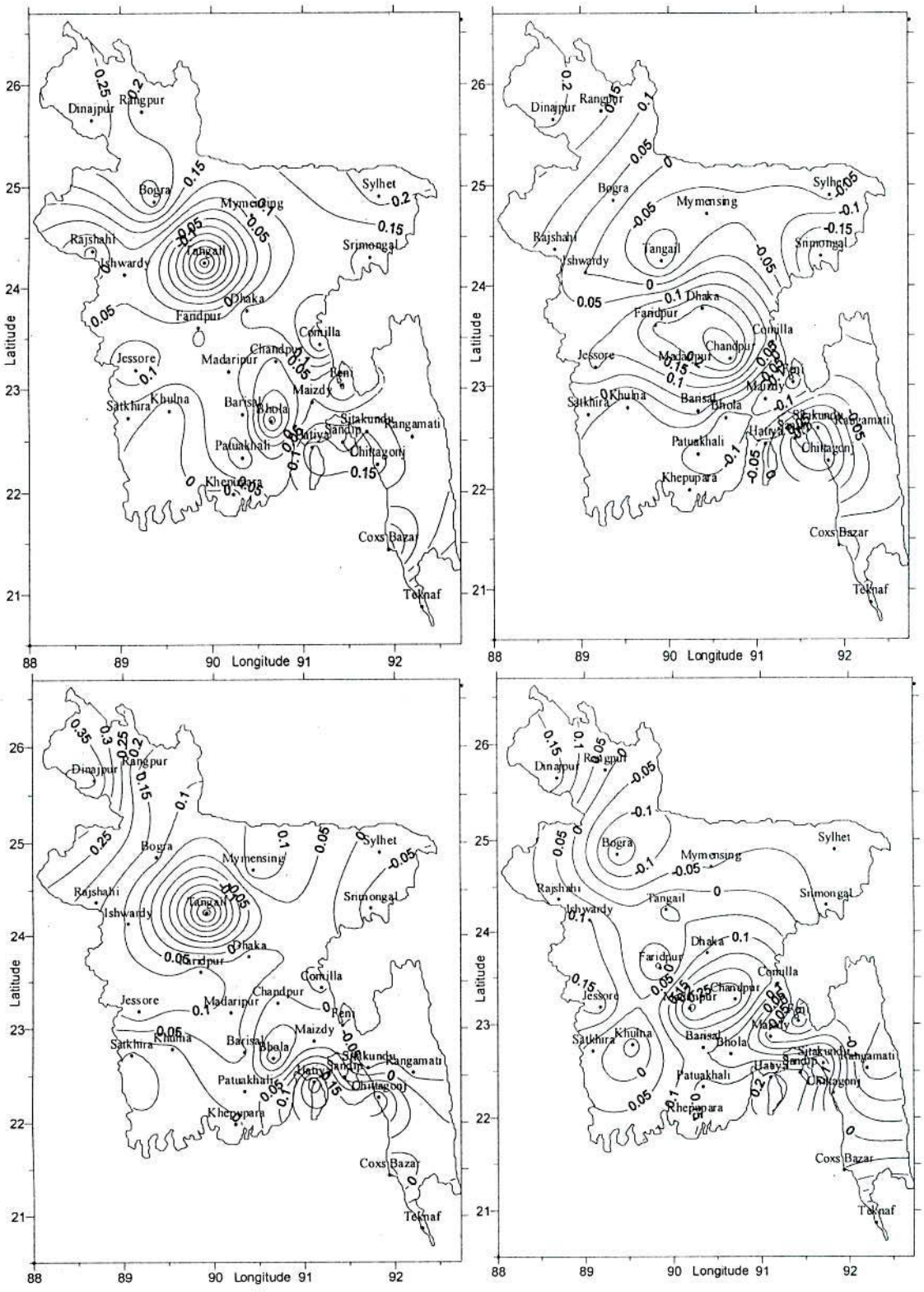


Fig 3.3.6(a-d): Correlation coefficients between WBT of June, July, August and September and Post-monsoon rainfall respectively

3.3.7 Distribution of CC between Rainfall of June, July, August and September and October Rainfall

June: The distribution of CC between the average Rainfall of June and the average rainfall of October all over Bangladesh is shown in Fig 3.3.7 (a). From the distribution pattern we observe that the CC is negative in the Srimongal, Bogra, Maizdy, Sitakundu and southwest region of the country. The CC is positive in the northwest, west and southern region of the country. The higher positive values of the CC are observed at Ishwardi and Hatiya and are 0.25 and 0.2 respectively.

July: The distribution of CC between the average rainfall of July and the average rainfall of October all over Bangladesh is shown in Fig 3.3.7 (b). The distribution shows that the CC is negative all over country except Ishwardy, Khulna, Hatiya, Madaripur, Patuakhali, Rangamati, Barisal and Cox's Bazar region. The maximum negative and positive values of the CC are observed at Bogra and Khulna and are -0.20 and 0.3 respectively. From the analysis we can say that the rainfall of July and the rainfall of October are the negatively correlated over maximum regions of the country i.e. for any increase in the rainfall of July the rainfall of October will be decreased.

August: The distribution of CC between the average rainfall of August and the average rainfall of October all over Bangladesh is shown in Fig 3.3.7 (c). From the distribution pattern we observe that the CC is positive over Jessore, Faridpur, Madaripur, Bogra, Rajshahi, Mymensing and Comilla region. The maximum positive CC is observed at Madaripur region and is 0.15. The maximum negative CC is observed at Tangail and is -0.35. From the analysis we can say that the average rainfall of August and the average rainfall of October are the negatively correlated in the maximum region of the country i.e. for the increase the rainfall of August the rainfall of October will be decreased.

September: The distribution of CC between the average rainfall of September and the average rainfall of October all over Bangladesh is shown in Fig 3.3.7 (d). From the distribution pattern we observe that the CC is positive all over country except Ishwardy and Sitakundu region where it is negative. The CC is highest at Tangail and next higher value is observed at Madaripur and Comilla region and are 0.45 and 0.35 respectively. From the analysis we can say that for any increase in the rainfall of September the rainfall of October will be increased.

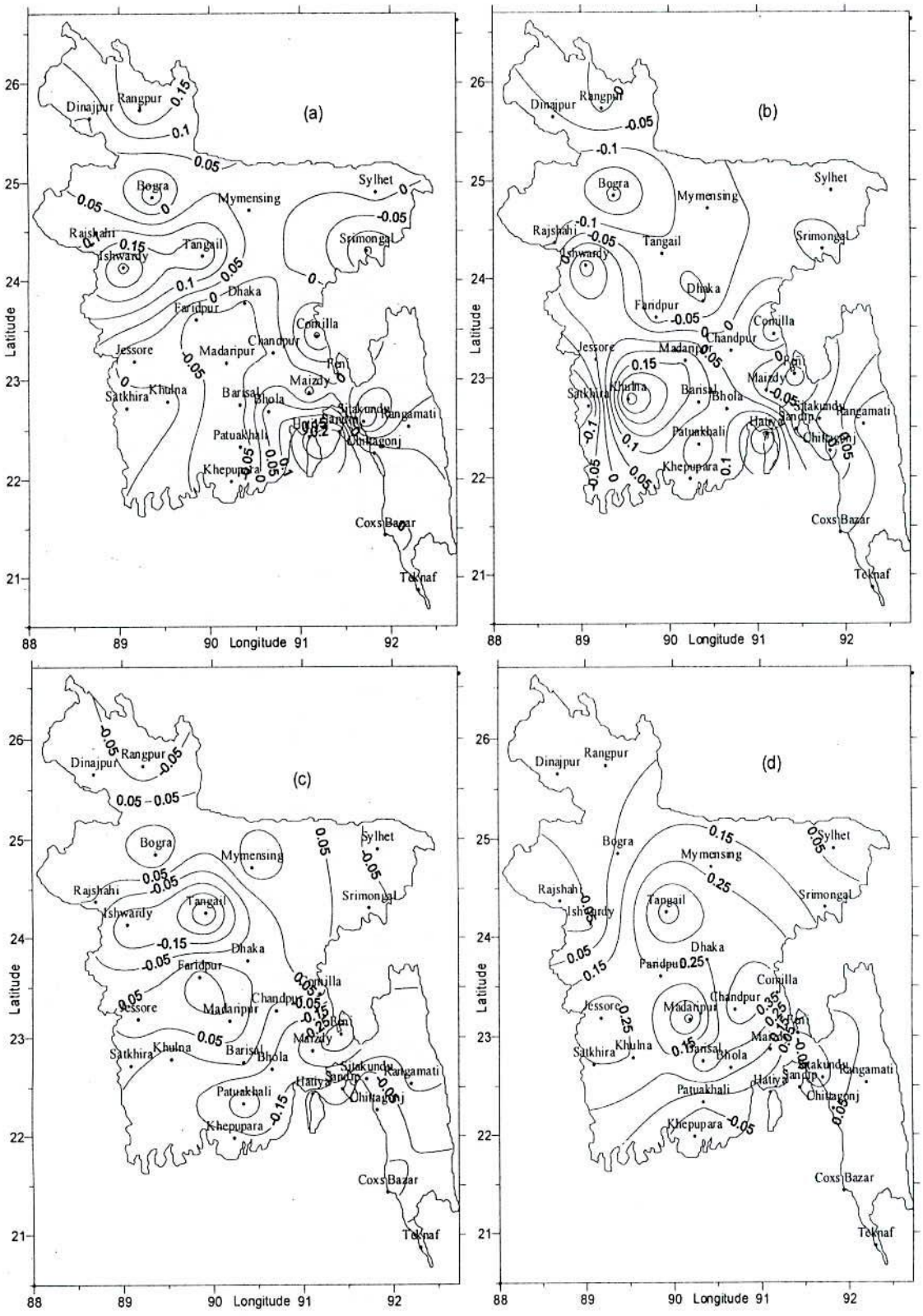


Fig 3.3.7(a-d): Correlation coefficients between rainfall of June, July, August and September and October rainfall respectively

3.3.8 Distribution of CC between Rainfall of June, July, August and September and November Rainfall

June: The distribution of CC between the average rainfall of June and the average rainfall of November all over Bangladesh is shown in Fig 3.3.8 (a). From the distribution pattern we have observed that the CC is positive all over the country except southern and eastern side of the country where the CC is negative. The maximum negative CC is observed at Sitakundu and is -0.20. The maximum positive CC is observed at Bogra and Tangail region and are 0.35 and 0.30 respectively.

July: The distribution of CC between the average rainfall of July and the average rainfall of November all over Bangladesh are shown in Fig 3.3.8 (b). The distribution pattern shows that the CC is positive all over country except Sylhet, Faridpur, Satkhira, Bhola and Maizdy-court region where the CC is negative. The maximum positive CC is observed at Bogra, Tangail and Mymensing region and its value is 0.20.

August: The distribution of CC between the average rainfall of August and the average rainfall of November all over Bangladesh is shown in Fig 3.3.8 (c). From the distribution pattern we observe that the CC is positive in the northern and eastern side and negative in the southern and southeastern side of the country. The maximum negative CC is observed at Patuakhali, Khepupara and Madaripur region where the value is -0.25. The maximum positive CC is observed at Sylhet region where the value is 0.40. The CC is significant at 99% level at Sylhet.

September: The distribution of CC between the average rainfall of September and the average rainfall of November all over Bangladesh is shown in Fig 3.3.8 (d). From the distribution pattern we observe that the CC is positive in the northern, southern and western region and negative in the central and eastern region of the country. The maximum negative value of CC is observed at Tangail and is -0.35. The maximum positive value of CC is observed at Dinajpur and Rangpur region and is 0.35 and at Sundarbon, Khepupara region the value of CC is 0.25. The CC is significant at 99% level at Rangpur and Dinajpur regions.

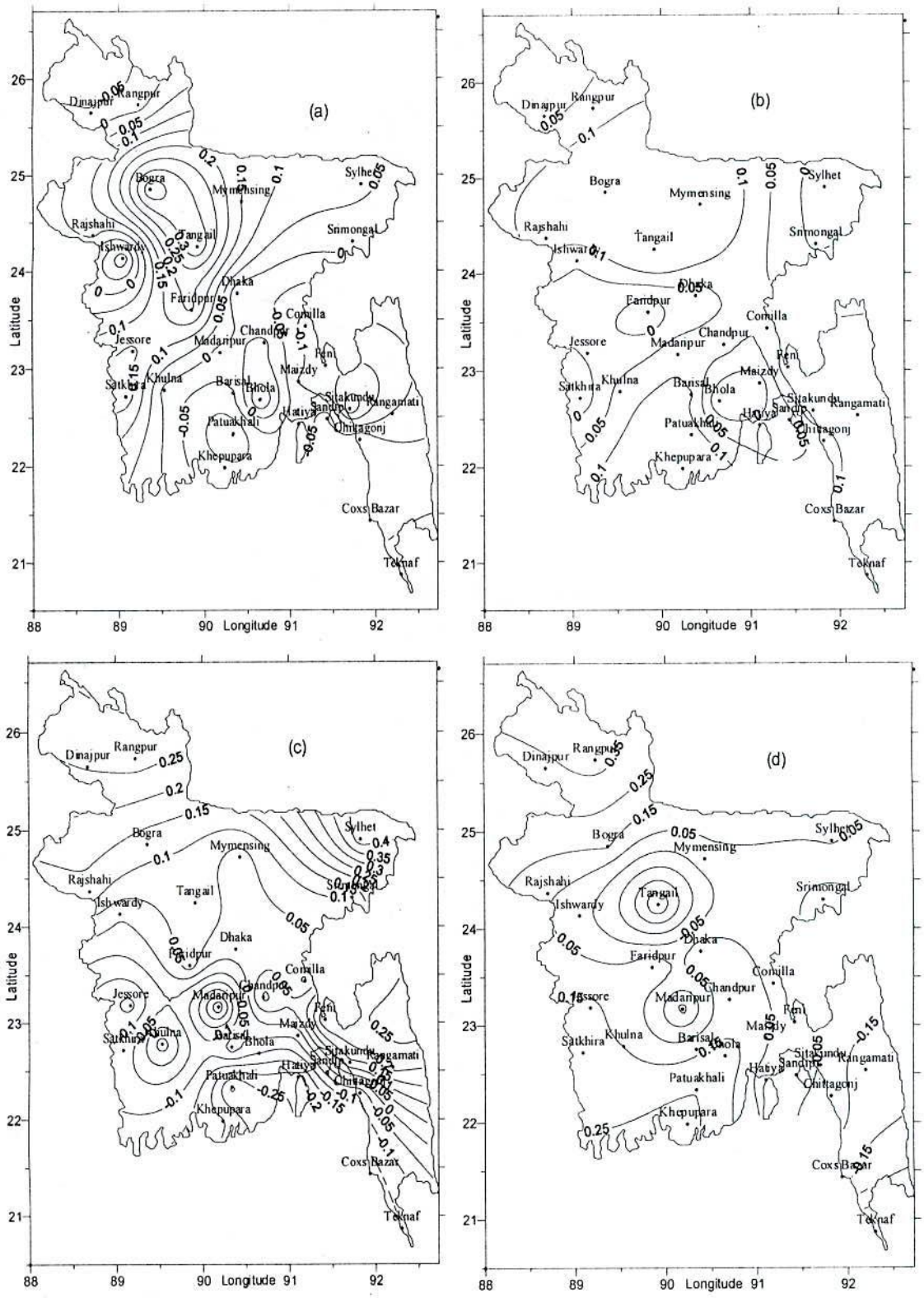


Fig 3.3.8(a-d): Correlation coefficients between rainfall of June, July, August and September and November rainfall respectively

3.3.9 Distribution of CC between Rainfall of June, July, August and September and Post-monsoon Rainfall

June: The distribution of CC between the average rainfall of June and the average rainfall of Post-monsoon season all over Bangladesh is shown in Fig 3.3.9 (a). From the distribution pattern we observe that the CC is positive over the maximum regions of the country and negative at Srimongal, Sitakundu-Rangamati region and Dhaka, Barisal, Patuakhali and Khepupara region. The maximum negative and positive CC are observed at Sitakundu and Tangail and are -0.20 and 0.30 respectively.

July: The distribution of CC between the average rainfall of July and the average rainfall of Post-monsoon all over Bangladesh is shown in Fig 3.3.9 (b). From the distribution pattern we observe that the CC is negative all over the country except southern and southeastern region. The maximum negative value –0.15 is observed at Bogra and Satkhira region. The maximum positive value 0.30 of the CC is observed at Khulna region.

August: The distribution of CC between the average rainfall of August and the average rainfall of Post-monsoon all over Bangladesh is shown in Fig 3.3.9 (c). From the distribution pattern we observe that the CC is positive over the northwest, northeast and Faridpur-Madaripur region of the country. The CC is negative over the maximum regions of the country. The maximum positive value of CC is observed at Bogra and is 0.25. The maximum negative CC is observed at Tangail and Patuakhali region where the value is –0.35.

September: The distribution of CC between the average rainfall of September and the average rainfall of Post-monsoon season all over Bangladesh is shown in Fig 3.3.9 (d). From the distribution pattern can observe that the CC is positive all over the country except Sitakundu region. The maximum positive value of the CC is observed at Chandpur, Comilla and Jessore region and is 0.35. Significant CC is observed all over the country during this month. From the analysis we can say that the rainfall of September and the rainfall of Post-monsoon are the positive correlated i.e. for the increase the rainfall of September the average rainfall of Post-monsoon season will be increased

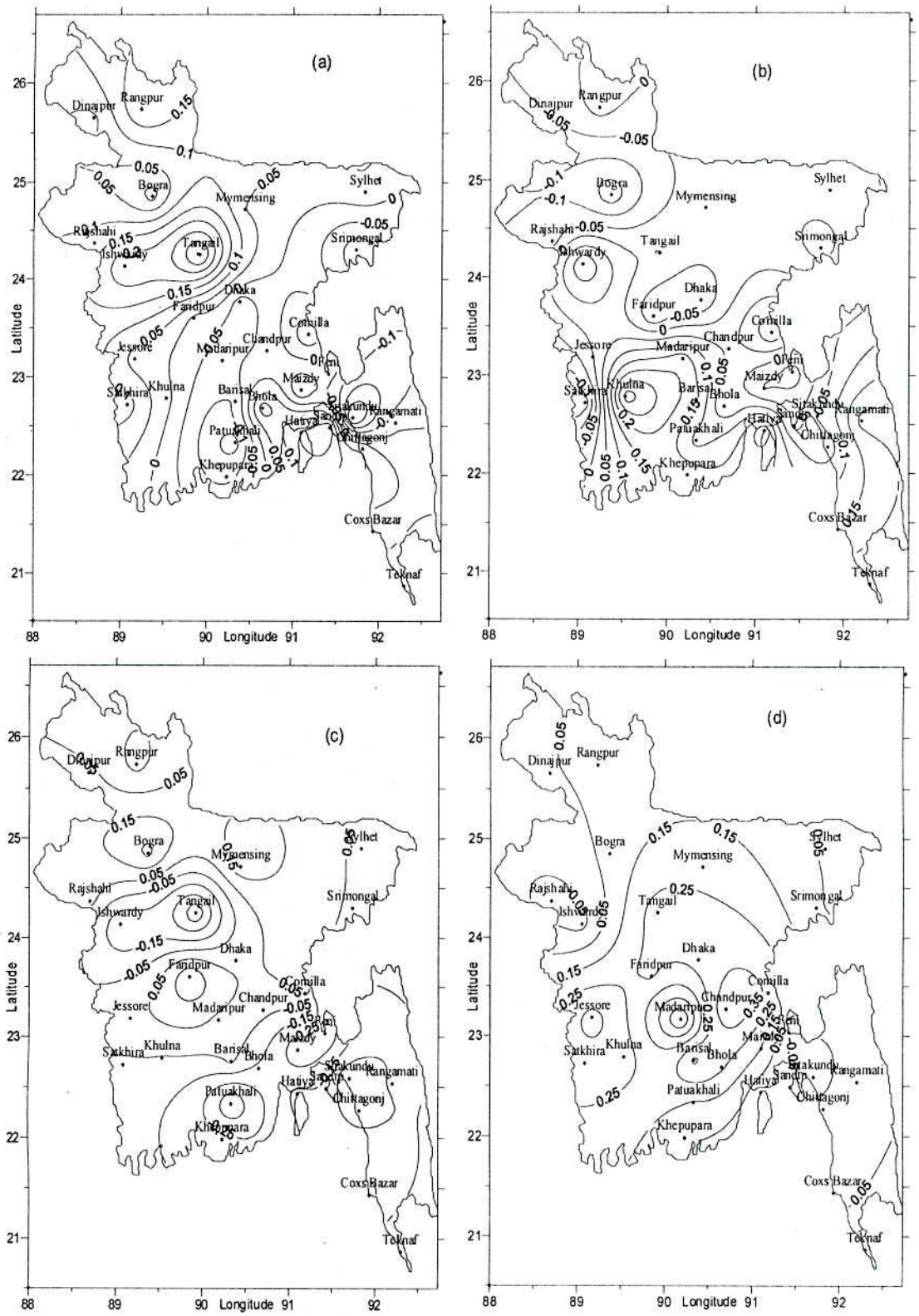


Fig 3.3.9(a-d): Correlation coefficients between rainfall of June, July, August and September and Post-monsoon rainfall respectively

3.3.10 Distribution of CC between monsoon DBT and the monthly Rainfall of October, November and Post-monsoon

October: The distribution of CC between DBT of monsoon and the average rainfall of October all over Bangladesh are shown in Fig 3.3.10 (a). From the distribution pattern we observe that the CC is negative in Tangail, Khulna, Satkhira, Maizdy, Rajshahi, Madaripur, Bhola, Patuakhali, Comilla, Rangamati, Cox's Bazar, Teknaf and Khepupara region and the CC is positive in the Dinajpur, Rangpur, Bogra, Sylhet, Srimongal, Mymensing, Ishwardy, Jessore Chandpur, Hatiya, Feni, Sandip, Sitakundu and Chittagong region. The maximum negative and positive CC are observed at Tangail and Ishwardy and are -0.35 and 0.30 respectively. The CC is significant about 95% level in Ishwardy region.

November: The distribution of CC between DBT of monsoon and the average rainfall of November all over Bangladesh is shown in Fig 3.3.10 (b). From the distribution pattern we observe that the CC is positive all over the country except Rajshahi, Ishwardy, Jessore, Mymensing, Sylhet, Srimongal and Bhola region. The maximum negative and positive CC are observed at Sylhet and Sitakundu region and are –0.25 and 0.45 respectively. The CC is significant about 99% level in Sitakundu region.

Post-monsoon: The distribution of CC between DBT of monsoon and the average rainfall of Post-monsoon all over Bangladesh is shown in Fig 3.3.10 (c). From the distribution pattern we observe that the CC is positive in most of the regions of the country except Tangail, Rajshahi, Sylhet, Comilla, Bhola, Khepupara, Maizdy and Patuakhali region. The maximum negative CC –0.25 is observed at Tangail and Rajshahi and the maximum positive CC 0.30 is observed at Ishwardy, Hatiya and Sitakundu region. The CC is significant about 97.5, 95 and above 90% level in Ishwardy, Hatiya and Sitakundu region.

3.3.11 Distribution of CC between monsoon WBT and the monthly Rainfall of October, November and Post-monsoon

October: The distribution of CC between WBT of monsoon and the average rainfall of October all over Bangladesh is shown in Fig 3.3.11 (a). From the distribution pattern we observe that the CC is positive all over the country except Tangail, Feni, Maizdy, Rangamati, Satkhira, Khepupara and Khulna region. The maximum negative and

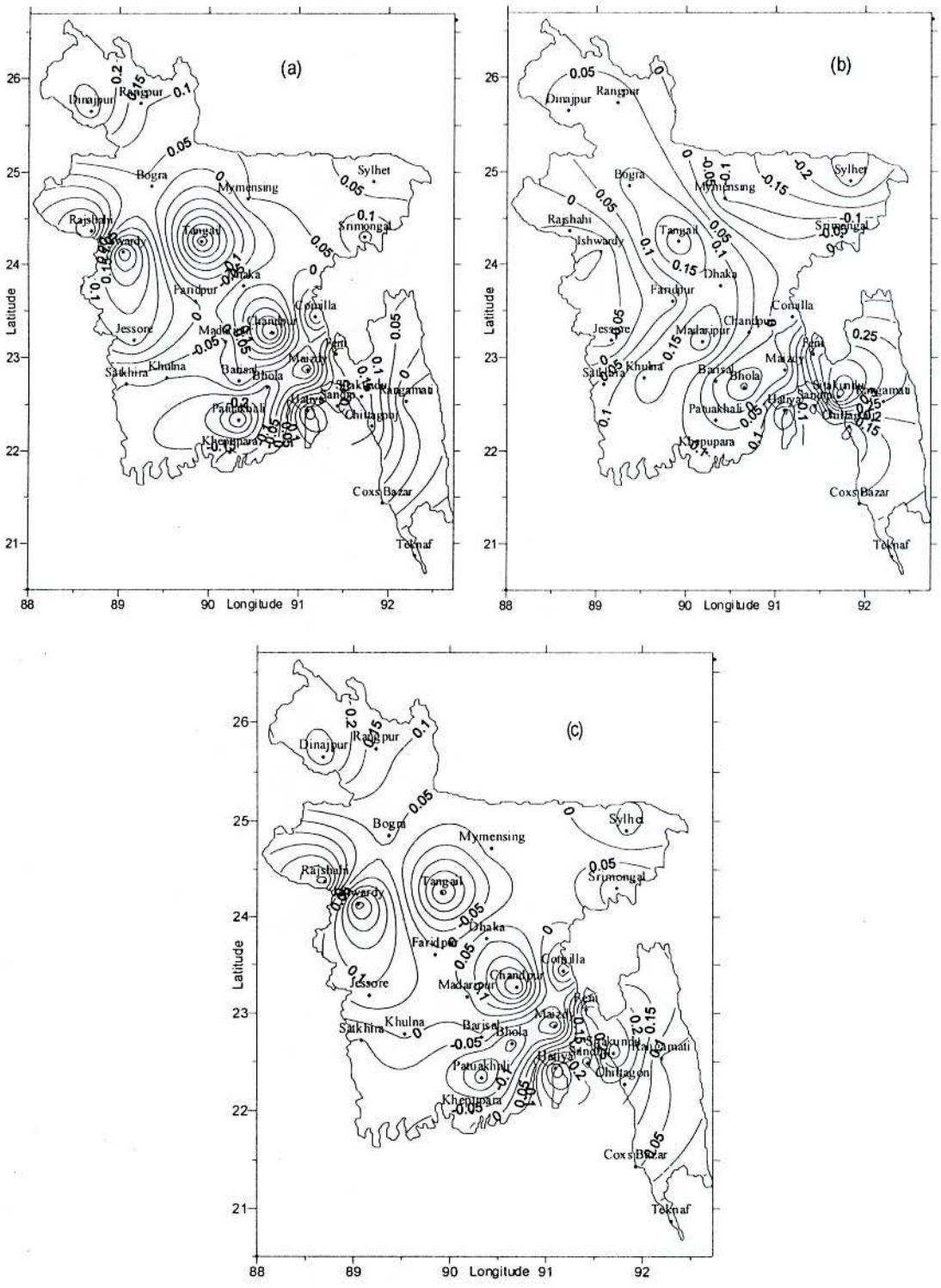


Fig 3.3.10(a-c): Correlation coefficients between monsoon DBT and the monthly rainfall of October, November and Post-monsoon respectively

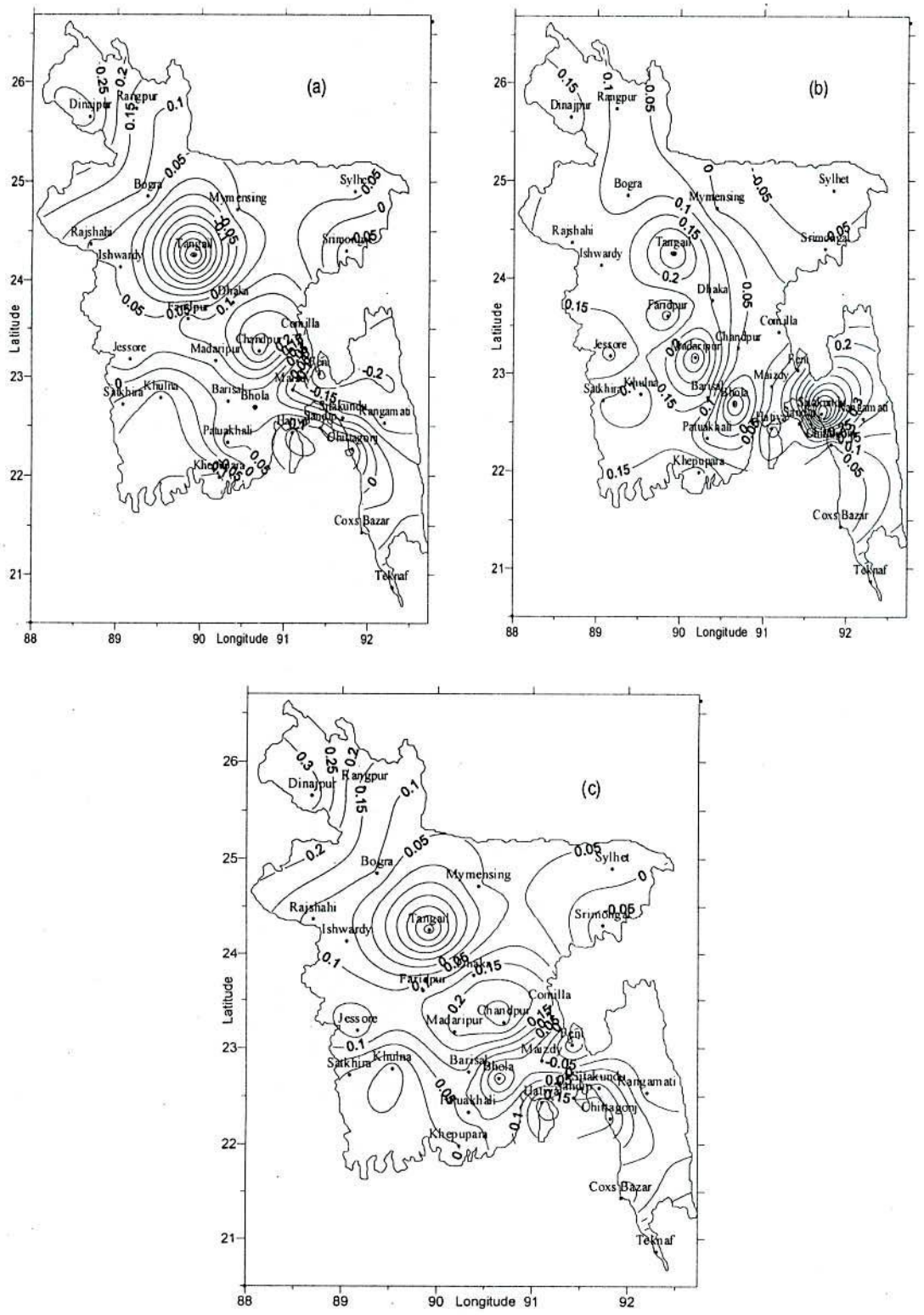


Fig 3.3.11(a-c): Correlation coefficients between monsoon WBT and the monthly rainfall of October, November and Post-monsoon respectively

positive CC are observed at Tangail and Dinajpur and are -0.40 and0.30 respectively. The CC is significant above 95% level in Dinajpur region.

November: The distribution of CC between WBT of monsoon and the average rainfall of November all over Bangladesh is shown in Fig 3.3.11 (b). From the distribution pattern we observe that the CC is positive all of the country except Sylhet, Srimongal and Bhola region. The maximum positive and negative CC are observed at Sitakundu and Bhola and are 0.60.and –0.15 respectively. The CC is significant above of 99% level in Sitakundu region.

Post-monsoon: The distribution of CC between WBT of monsoon and the average rainfall of Post-monsoon all over Bangladesh is shown in Fig 3.3.11 (c). The distribution shows that the CC is positive all over country except Tangail, Srimongal, Bhola, Maizdy, Feni, Rangamati, Khulna and Teknaf region. The maximum positive and negative CC are observed at Dinajpur and Tangail and are 0.30 and –0.25 respectively the CC is significant above 95% level in Dinajpur region.

3.3.12 Distribution of CC between monsoon rainfall and the rainfall of October, November and Post-monsoon

October: The distribution of CC between the monsoon rainfall and October rainfall all over Bangladesh is shown in Fig 3.3.12 (a). We observe that the CC is positive all over the country except Srimongal, Feni, Maizdy court, and Sitakundu, Patuakhali and Khepupara region. The maximum negative and positive CC are observed at Feni and Khulna region and is -0.20 and 0.20 respectively.

November: Fig 3.3.12 (b) represents the distribution of CC between the rainfall of monsoon season and rainfall of month of November all over Bangladesh. We have observed that the CC is positive all over the country except Madaripur Ishwardy, Hatiya, Maizdy-court and Cox's Bazar region. The maximum negative CC is observed at Madaripur and Hatiya and -0.10. The maximum positive CC is observed at Bogra region and is 0.40. From the analysis we say that the rainfall of monsoon and month of November are positively correlated in most of the regions. The CC is significant at 99 % level at Bogra region.

Post-monsoon: - Fig 3.3.12 (c) shows the distribution of CC between the rainfall of monsoon and Post-monsoon season all over Bangladesh. From the distribution pattern

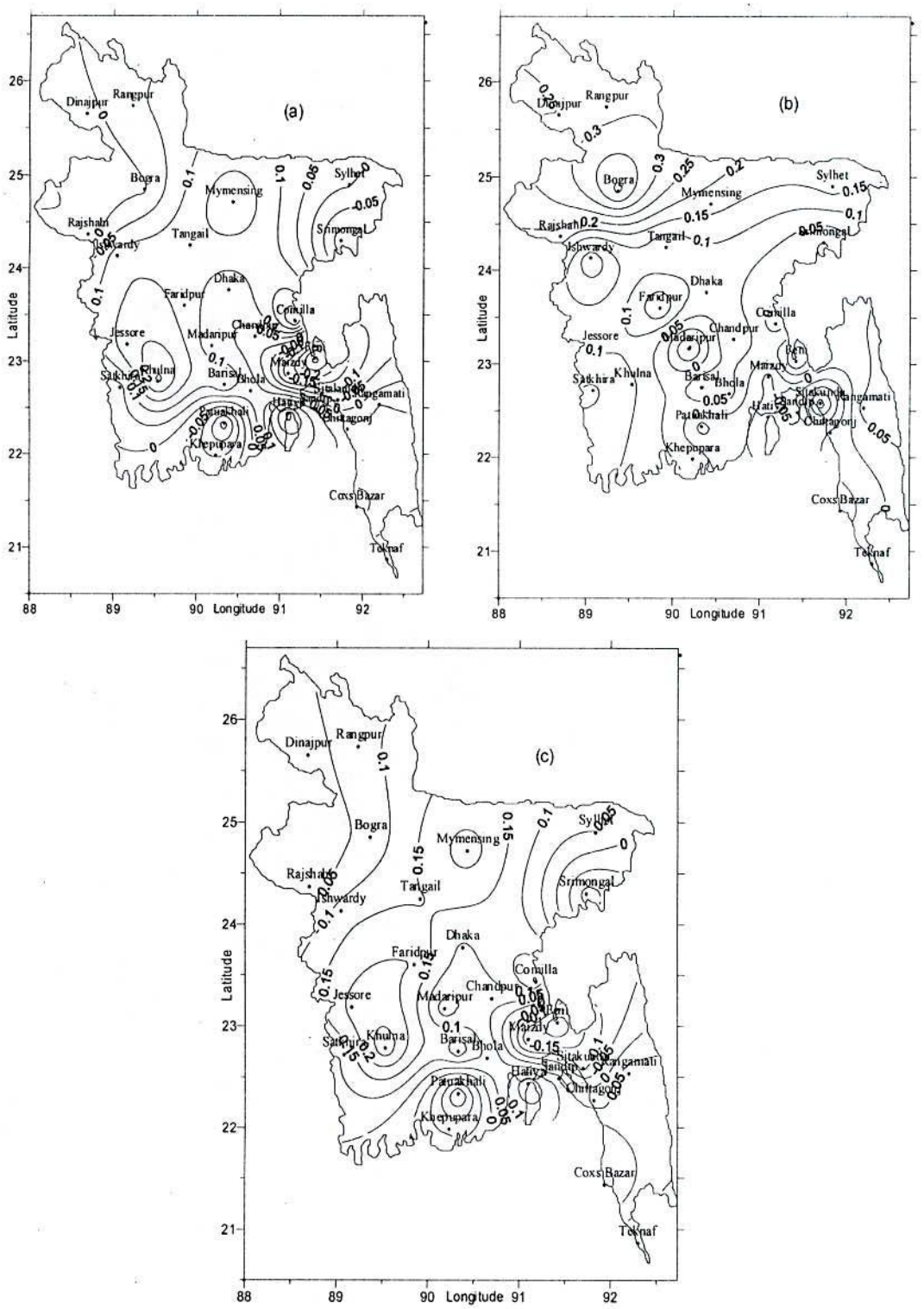


Figure 3.3.12(a-c): Correlation coefficients between monsoon rainfall and the rainfall of October, November and Post-monsoon respectively

we have observed that the CC is positive all over the country except Feni, Maizdy-court, Sitakundu, Patuakhali, Khepupara and Teknaf. The maximum positive and negative CC are observed at Khulna and Patuakhali, Feni and Maizdy-court regions and are 0.25 and – 0.15 respectively.

3.3.13 Distribution of CC between DBT and WBT of June, July, August and September

June: The distribution of CC between DBT and WBT of June all over Bangladesh is shown in Fig 3.3.13 (a). The distribution shows that the CC is positive all over the country. The maximum positive CC is observed at Rangpur, Tangail, and Dhaka region and is 0.9. The next highest CC is observed at Bogra, Faridpur, Barisal, Bhola Patuakhali, Hatiya, Maizdy-court, Feni, Rangamati, Chittagonj and Cox's Bazar region. From the figure it is observed that the CC decreases from central region towards the east and west. The lowest CC is observed at Rajshahi, Ishwardy, Jessore and Srimongal region and is 0.20. Over most of the regions of the country the CC is significant at 99% level.

July: The distribution of CC between DBT and WBT of July all over Bangladesh is shown in Fig 3.3.13 (b). The distribution shows that the CC is positive all over the country. The maximum positive CC is observed at Rangpur and its value is .95. The next highest CC is observed at Bogra, Faridpur, Dhaka, Patuakhali, Bhola, Hatiya, Maizdy and Rangamati region. From the figure it is also observed that the CC is decreases from central region towards east and west. The lowest CC is observed at Rajshahi and Sylhet region and is 0.15. Over most of the regions of the country the CC is significant at 99% level.

August: Fig 3.3.13 (c) represents the distribution of CC between DBT and WBT of August all over Bangladesh. The distribution shows that the CC is positive all over Bangladesh. The maximum positive CC is observed at Rangpur and is 0.95. The next highest CC is observed at Bogra, Dhaka, and Maizdy-court region and is 0.85. From the figure it is also observed that the CC is decreases from the central region towards east and west. The lowest CC is observed at Rajshahi and Sylhet region and its value is 0.15.Over maximum regions of the country the CC is significant at 99% level.

September: The distribution of CC between DBT and WBT of September all over Bangladesh is shown in Fig 3.3.13 (d). The distribution shows that the CC is the positive

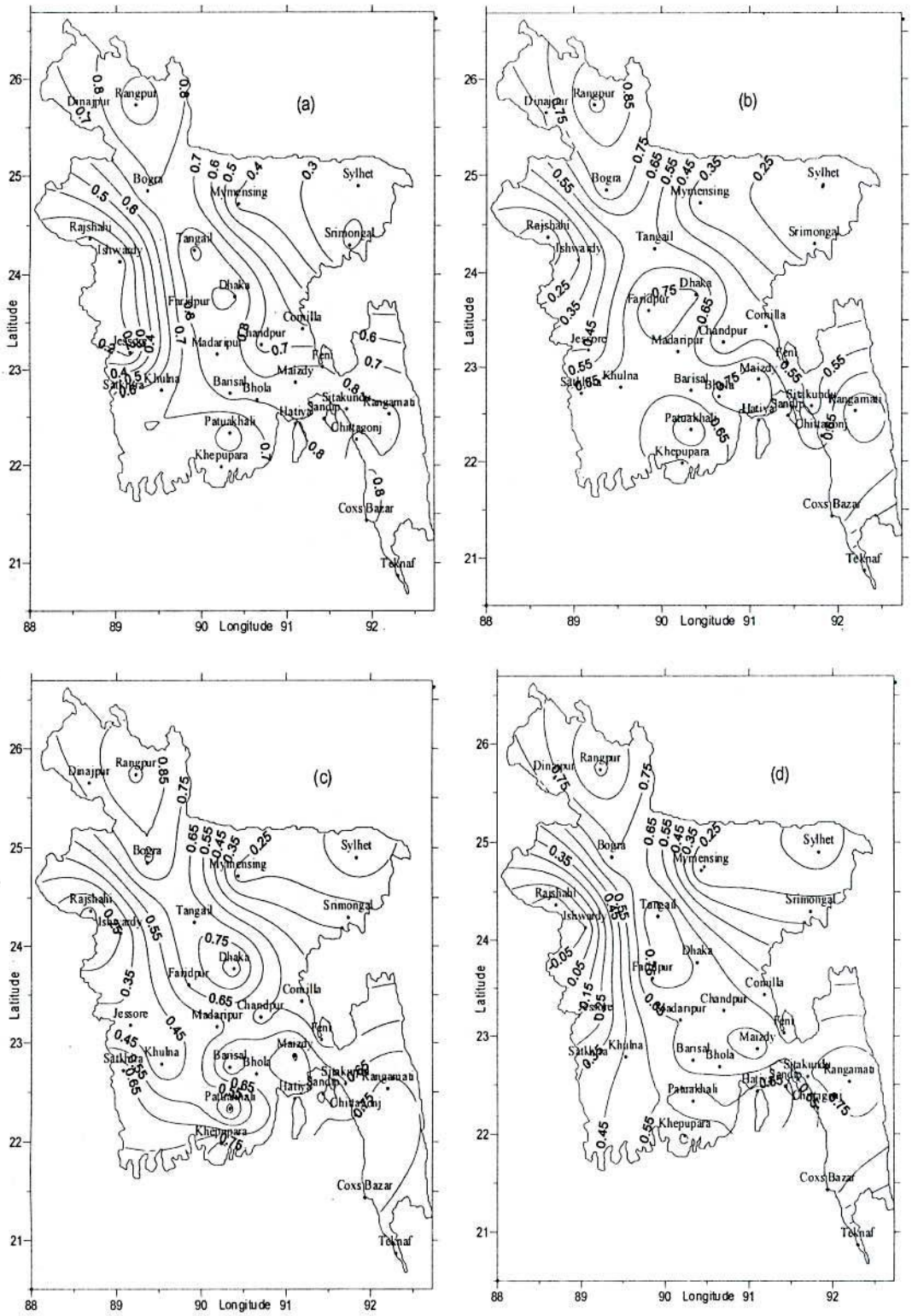


Fig 3.3.13(a-d): Correlation coefficients between DBT and WBT of June, July, August and September respectively

all over the country except Ishwardy and Rajshahi region value is -0.05. The maximum positive CC is observed at Rangpur region and is 0.95. The next highest CC is observed at Dinajpur, Bogra, Tangail, Dhaka, Faridpur, Maizdy-court and Rangamati region and its value is 0.75. From the figure it is also observed that the CC decreases from the central region towards west and northeast. The lowest CC is observed at Sylhet region and is 0.15. The CC of the central region of the country is significant at 99% level.

3.3.14 Distribution of CC between DBT and Rainfall of June, July, August and September

June: The distribution of CC between the DBT and Rainfall of June all over Bangladesh are shown in Fig 3.3.14 (a). The distribution shows that the CC is negative all over the country except Jessore where it is 0.2. The maximum negative CC is observed at Chandpur and its value is- 0.8. The next highest negative CC is observed at Tangail, Barisal, Cox's Bazar, Rangamati, Feni and Comilla region and is –0.6. From the analysis we can say that the DBT and Rainfall of June are the negatively correlated i.e. for increase in the DBT rainfall of June will be decreased.

July: The distribution of CC between DBT and Rainfall of July all over Bangladesh is shown in Fig 3.3.14 (b). The distribution pattern shows that the CC is negative all over the country except Chandpur, Ishwardy, Patuakhali, Mymensing and Sylhet region. The maximum positive CC is observed at Mymensing and Feni and is 0.15. The maximum negative CC is observed at Dinajpur and is –0.55. The next minimum value of CC is observed at Dhaka, Faridpur, Comilla and Chittagonj region and is –0.45. From the analysis we can say that the DBT and Rainfall of July are the negatively correlated i.e. for increase in the DBT rainfall of July will decrease.

August: Fig 3.3.14 (c) represents the distribution of CC between DBT and Rainfall of August all over Bangladesh. Here we observe that the CC is negative all over the country except Jessore where it is 0.1. The maximum negative CC is observed at Dhaka, Sitakundu and Sandip and is -0.4. From the analysis we can say that with the increase in the DBT of August the rainfall of August will decrease.

September: The distribution of CC between DBT and Rainfall of September all over Bangladesh is shown in Fig 3.3.14 (d). The distribution pattern shows that the CC is negative all over the country except Jessore where it is 0.1. The maximum negative CC is observed at Dhaka, Sandip, Sitakundu and Feni region and is –0.4. From the analysis we can say that for the increase of the DBT of September the rainfall will decreased.

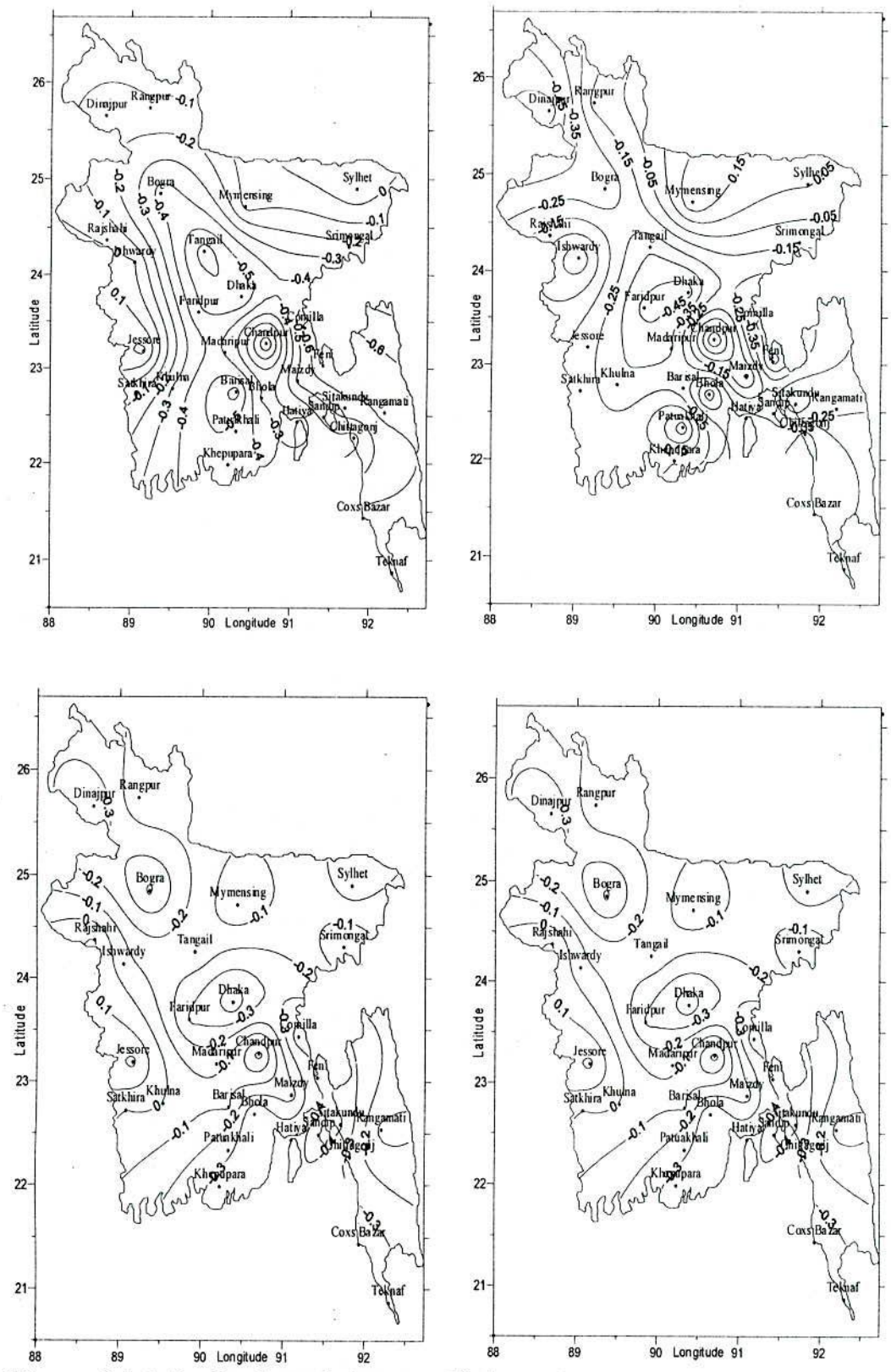


Figure 3.3.14(a-d): Correlation coefficients between DBT and rainfall of June, July, August and September respectively

3.3.15 Distribution of CC between WBT and Rainfall of June, July, August and September

June: The distribution of CC between the WBT and rainfall of June all over Bangladesh is shown in Fig 3.3.15 (a). The distribution shows that the CC is negative all over the country except Dinajpur where its value is 0.05. The maximum negative CC is observed at Srimongal, Mymensing, Tangail, Dhaka, Feni and Sitakundu and is -0.45. From the analysis we can say that the WBT and rainfall of June are the negatively correlated i.e. for any increase in the WBT of June the rainfall will decrease.

July: The distribution of CC between WBT and rainfall of July all over Bangladesh is shown in Fig 3.3.15 (b). The distribution shows that the CC is negative all over country except Patuakhali, Sitakundu and Chandpur region. The maximum negative and positive CC are observed at Sylhet and Patuakhali- Sitakundu regions and are –0.45 and 0.25 respectively.

August: Fig 3.3.15 (c) shows the distribution of CC between WBT and rainfall of August all over Bangladesh. Here we observe that the CC is negative all over the country except Khulna, Tangail and Chandpur region and its maximum positive value is 0.25. The maximum negative CC is observed at Mymensing and Sylhet region and its value is -0.45.

September: The distribution of CC between the WBT and rainfall of September all over Bangladesh is shown in Fig 3.3.15 (d). The distribution shows that the CC is negative all over the country except Dinajpur and Chandpur region where its value is 0.05. The maximum negative CC is observed at Bhola and is –0.45. The next negative CC is observed at Tangail and Sylhet and is –0.4. From the analysis we can say that the WBT and rainfall of September is negatively correlated i.e. for increase in the WBT of September the rainfall will decrease.

3.3.16 Distribution of CC between DBT & WBT, DBT & rainfall and WBT & rainfall of monsoon season

DBT and WBT: - The distribution of CC between DBT and WBT of monsoon all over Bangladesh is shown in Fig 3.3.16 (a). The distribution shows that the CC is positive all over the country. The maximum CC is observed at Bogra, Faridpur, Tangail, Dhaka,

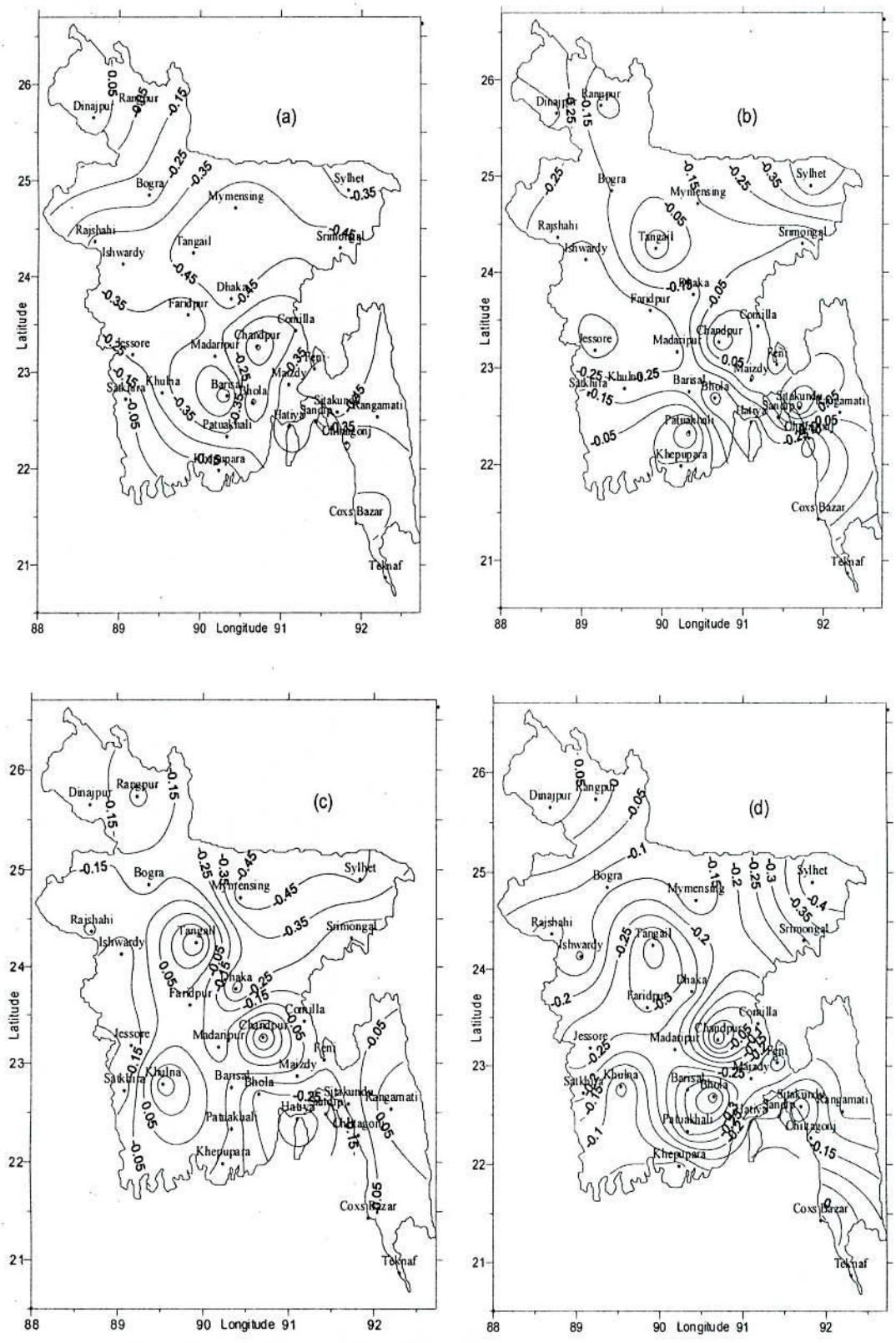


Fig 3.3.15(a-d): Correlation coefficients between WBT and rainfall of June, July, August and September respectively

Maizdy-court, and Rangamati and Khepupara region. From the figure it is also observed that the CC decreases from central region towards east and west. The lowest CC is observed and Rajshahi- Ishwardy region and is 0.20. Maximum regions of the country the CC is significant at 99% level.

DBT and rainfall: - The distribution of CC between DBT and rainfall of monsoon all over Bangladesh is shown in Fig 3.3.16 (b). Here we observe that the CC is negative all over the country except Rangpur, Mymensing, Jessore, Patuakhali, Chandpur and Khepupara region. The maximum negative and positive CC are observed at Feni and Patuakhali region and are -0.50 and 0.30 respectively.

WBT and rainfall: The distribution of CC between the WBT and rainfall of monsoon all over Bangladesh is shown in Fig 3.3.16 (c). Figure shows that the CC is negative all over the country except north, west and southern part of the country. The maximum negative and positive CC are observed at Feni and Patuakhali and are -0.50 and 0.30 respectively.

From the above analysis we have found that the DBT & rainfall of monsoon season and WBT & rainfall of monsoon season almost give the identical results.

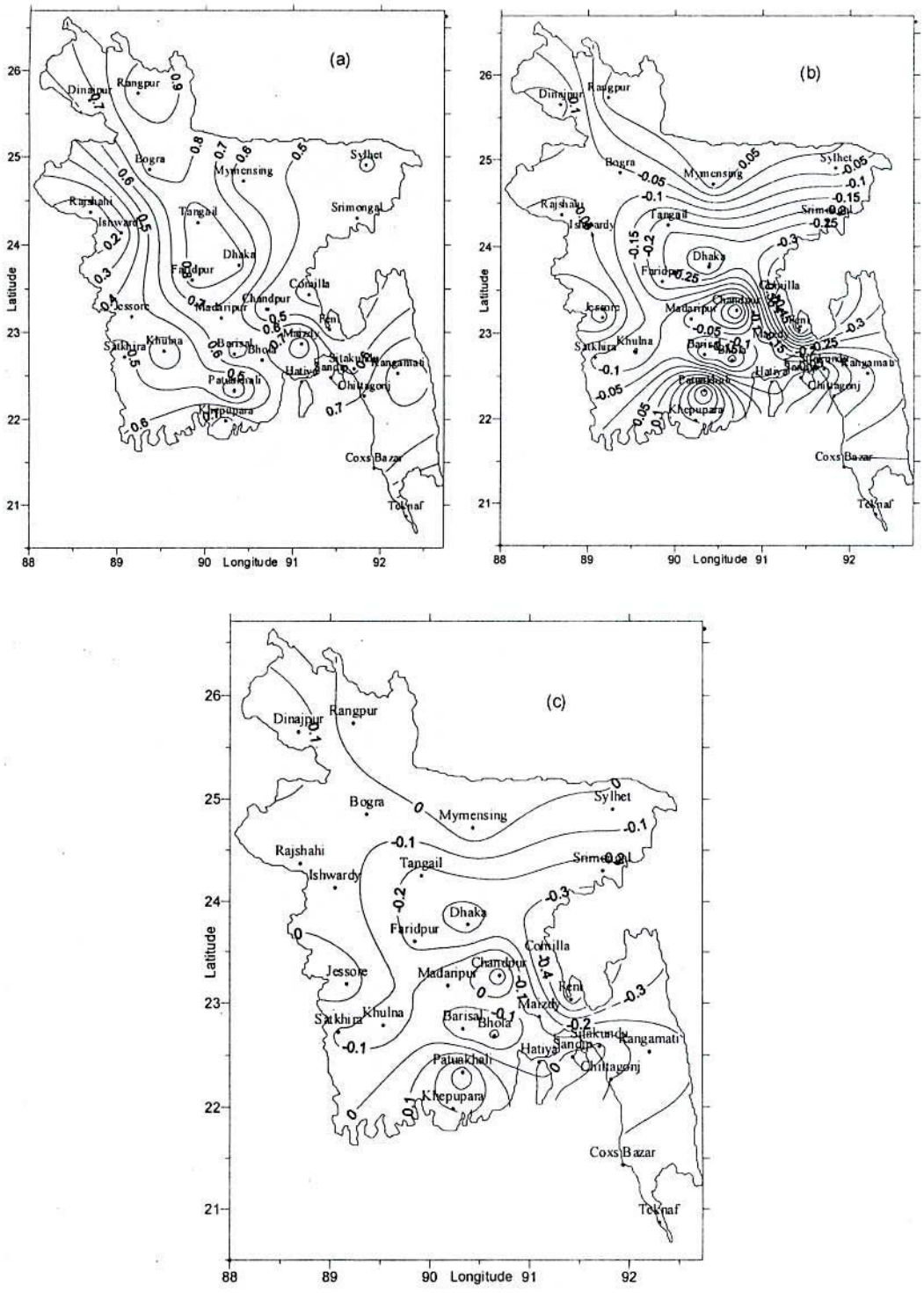


Fig 3.3.16(a-c): Correlation coefficients between DBT &WBT, DBT & Rainfall, WBT & Rainfall of monsoon season respectively

3.4 Correlation Coefficients between rainfall of Post-monsoon and 2 parameters of monsoon

3.4.1 Distribution of CC between October rainfall and WBT & DBT of June, July, August and September

June: The distribution of CC between rainfall of October and WBT & DBT of June all over Bangladesh is shown in Fig 3.4.1 (a). From the distribution pattern we observe that the CC is positive all over the country except southeast and southern side i.e. Khepupara, Hatiya, Feni, Sitakundu, Sandip, Rangamati region. The maximum negative and positive CC are observed at Feni and Dinajpur-Bogra region and are –0.40 and 0.2 respectively. In this month the magnitude of CC is in almost all other region lies between 0 and 0.1.

July: The distribution CC between rainfall of October and WBT & DBT of July all over Bangladesh are shown in Fig 3.4.1 (b). From the distribution pattern we observe that the CC is positive in the northwest and central region of the country. The negative CC is observed in the northeast and southearn side of the country. The maximum negative and positive CC are observed at Tangail and Chandpur and are -0.35 and 0.2 respectively.

August: The distribution of CC between rainfall of October and WBT & DBT of August all over Bangladesh is shown in Fig 3.4.1 (c). The distribution pattern shows that the CC is positive at Tangail, Dhaka, Chandpur, Barisal, Feni, Sitakundu and Rangamati region. The maximum positive CC is observed at Feni and Sitakundu region and is 0.35. The negative CC is observed at Rajshahi, Mymensing, Sylhet, Srimongal, Comilla and Madaripur region. The maximum negative CC is observed at Mymensing region and is -0.15.

September: The distribution of CC between rainfall of October and WBT & DBT of September all over Bangladesh is shown in Fig 3.4.1 (d). The distribution shows that the CC is negative all over the country except Chandpur, Southeastern and Northern side of the country. The maximum negative and positive CC are observed at Patuakhali and Chandpur region and are -0.3 and 0.2 respectively. The positive CC is observed in the northern side of the country and is comparatively low. In the maximum regions the CC lies between –0.1 to 0.1.

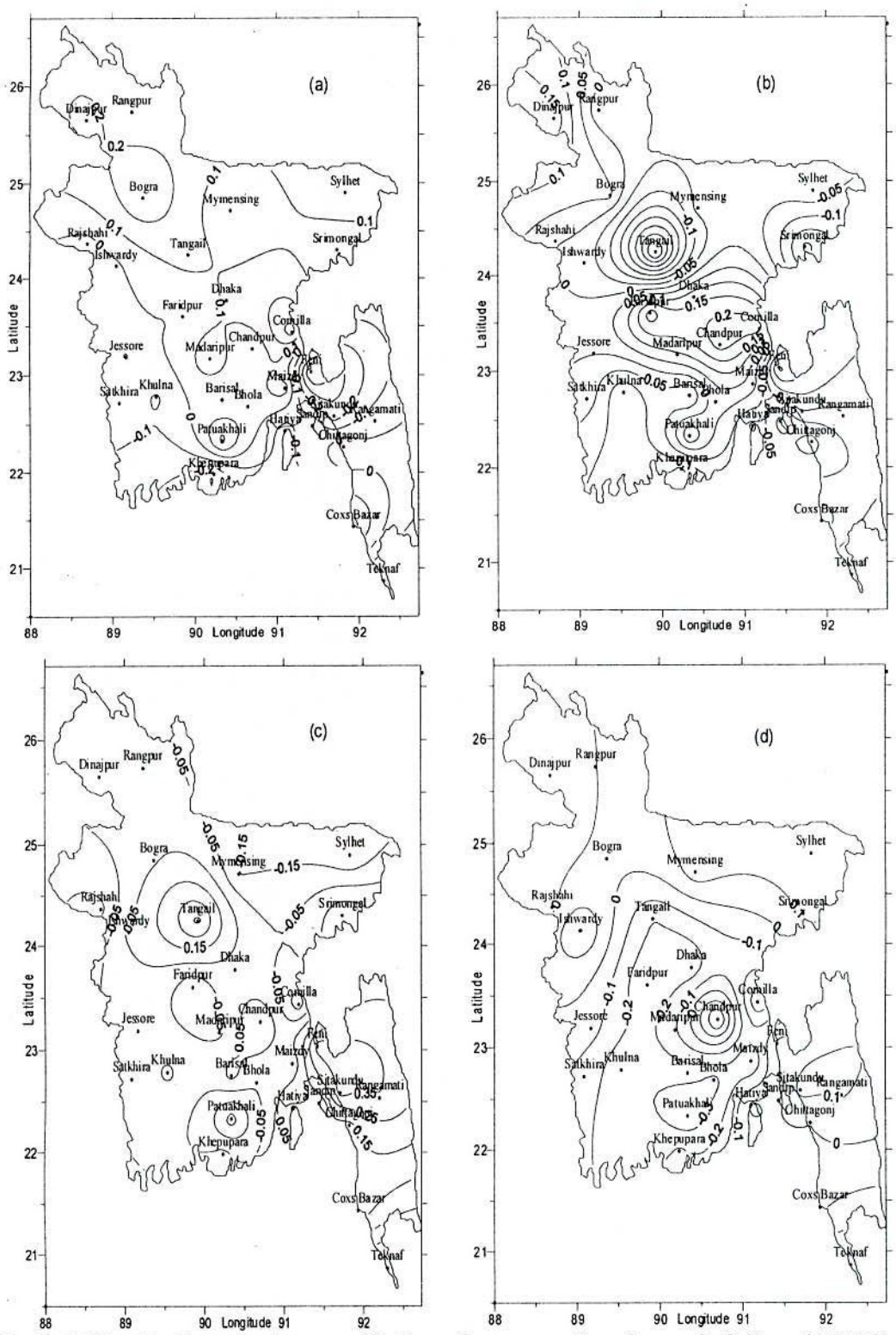


Fig 3.4.1(a-d): Correlation coefficients between October rainfall and WBT & DBT of June, July, August and September respectively

3.4.2 Distribution of CC between November rain and WBT & DBT of June, July, August and September

June: The distribution of CC between rainfall of November and WBT & DBT of June all over Bangladesh is shown in Fig 3.4.2 (d). The distribution shows that the CC is positive all over the country except Bhola where its value is –0.15. The maximum positive CC is observed at Tangail and Sitakundu region and is 0.35. The lowest positive CC of 0.1is observed at Bogra, Jessore, Khulna, Chandpur, Patuakhali and Cox's Bazar region. Thus we can say that rainfall of November and WBT & DBT of June are positively correlated.

July: The distribution of CC between rainfall of November and WBT & DBT of July all over Bangladesh is shown in Fig 3.4.2 (b). From the distribution pattern we observe that the CC is positive all over the country except Mymensing, Sylhet, Srimongal, Comilla, Bhola, Cox's Bazar and Patuakhali region. The maximum negative and positive CC are observed at Srimongal and Rajshahi-Madaripur region and are –0.15 and 0.30 respectively. The next highest positive CC is observed at Sitakundu region and is 0.25. From the analysis we can say that the over most of the places the rainfall of November and WBT & DBT of July are positively correlated.

August: The distribution of CC between rainfall of November and WBT & DBT of August all over Bangladesh is shown in Fig 3.4.2 (c). From the distribution shows that the CC is negative over the northern and positive over the southern side of the country. The negative CC is upto -0.15 and the positive CC is upto 0.15

September: The distribution of CC between rainfall of November and WBT & DBT of September all over Bangladesh is shown in Fig 3.4.2 (d). From the distribution pattern we observe that the CC is positive all over the country except Mymensing, Barisal, Patuakhali, Khepupara, Maizdy-court, Hatiya and Sandip region. The maximum negative and positive CC are observed at Patuakhali and Tangail- Madaripur region and are –0.25 and 0.25 respectively.

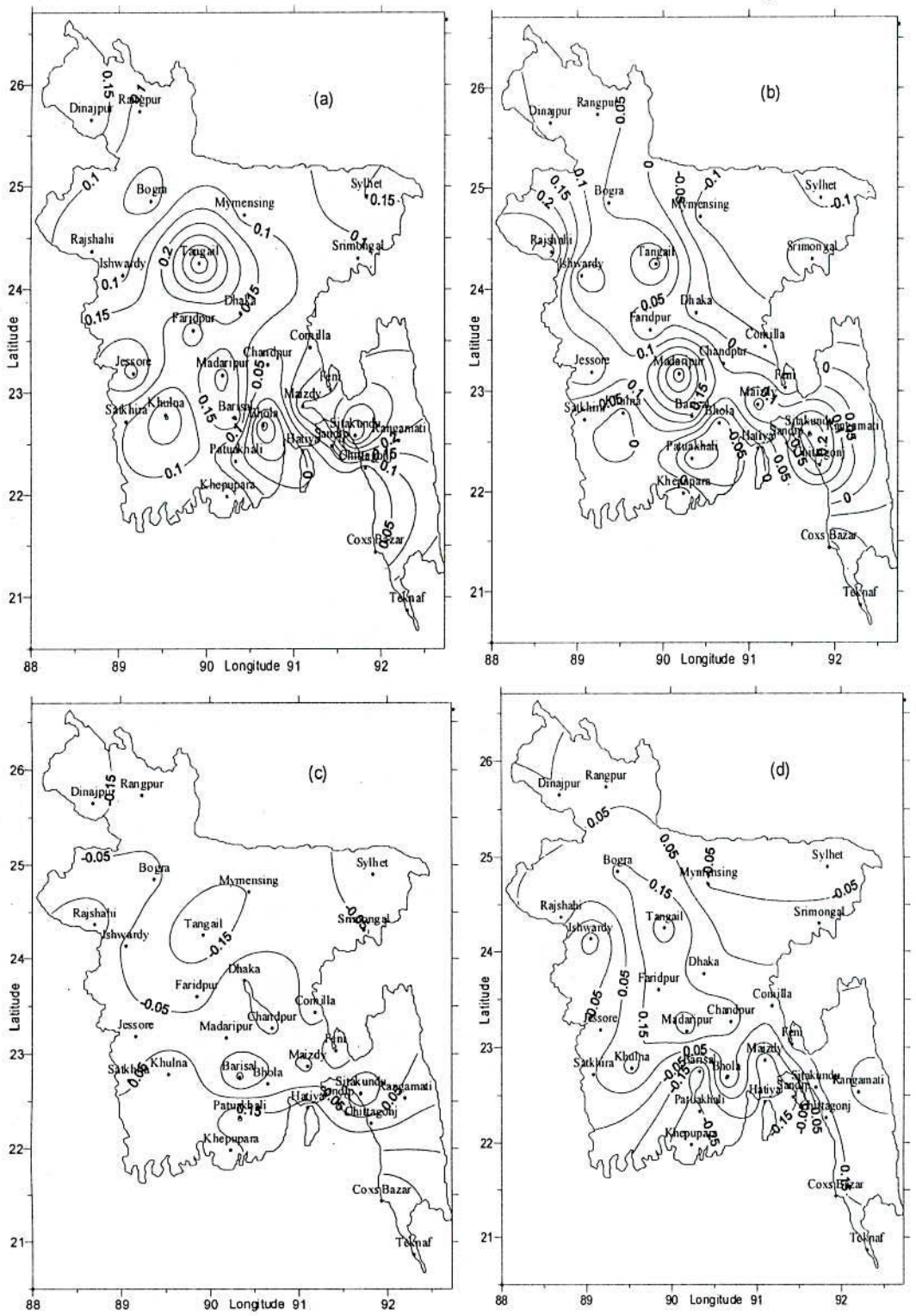


Fig 3.4.2(a-d): Correlation coefficients between November rain and WBT& DBT of June, July, August and September respectively

3.4.3. Distribution of CC between Post-monsoon rain and WBT & DBT of June, July, August and September

June: The distribution of CC between rainfall of Post-monsoon and WBT & DBT of June all over Bangladesh is shown in Fig 3.4.3 (a). From the distribution pattern we observe that the CC is positive all over the country except Khulna, Khepupara, Bhola, Hatiya, Fani, Sitakundu and Sandip region. The maximum negative and positive CC are observed at Feni and Bogra- Tangail region and are –0.35 and 0.25 respectively.

July: The distribution of CC between rainfall of Post-monsoon and WBT & DBT of July all over Bangladesh is shown in Fig3.4.3 (b). The distribution shows that the CC is positive in the northwest and central region of the country. The negative CC is observed at Tangail, Mymensing, Sylhet, Srimongal Khulna, Patuakhali, Bhola, Hatiya, Feni, Sitakundu and Rangamati region. The maximum negative and positive CC is observed at Tangail and Chandpur- Madaripur region and are-0.3 and 0.2 respectively.

August: The distribution of CC between rainfall of Post-monsoon and WBT & DBT of August all over Bangladesh is shown in Fig 3.4.3 (c). From the distribution pattern we observe that the CC is positive all over the country except Mymensing, Srimongal, Comilla, Faridpur and Madaripur region. The maximum negative CC is observed at Sitakundu, region and is –0.15 and the maximum positive CC is observed at Feni and Rangamati region and is 0.35. The CC is Feni-Rangamati region is significant at 99% level

September: The distribution of CC between rainfall of Post-monsoon WBT & DBT of September all over Bangladesh is shown in Fig 3.4.3 (d). From the distribution pattern we observe that the CC is negative over Tangail, Mymensing, Sylhet, Srimongal, Khulna, Patuakhali, Bhola, Hatiya, Feni, Sitakundu and Rangamati region. The maximum negative and positive CC are observed at Tangail and Chandpur- Madaripur regions and are -0.3 and 0.2 respectively.

3.4.4 Distribution of CC between October rainfall and WBT & Rainfall of June, July August and September

June: The distribution of CC between October rainfall and WBT & rainfall June all over Bangladesh is shown in fig 3.4.4 (a). The distribution pattern shows that the CC

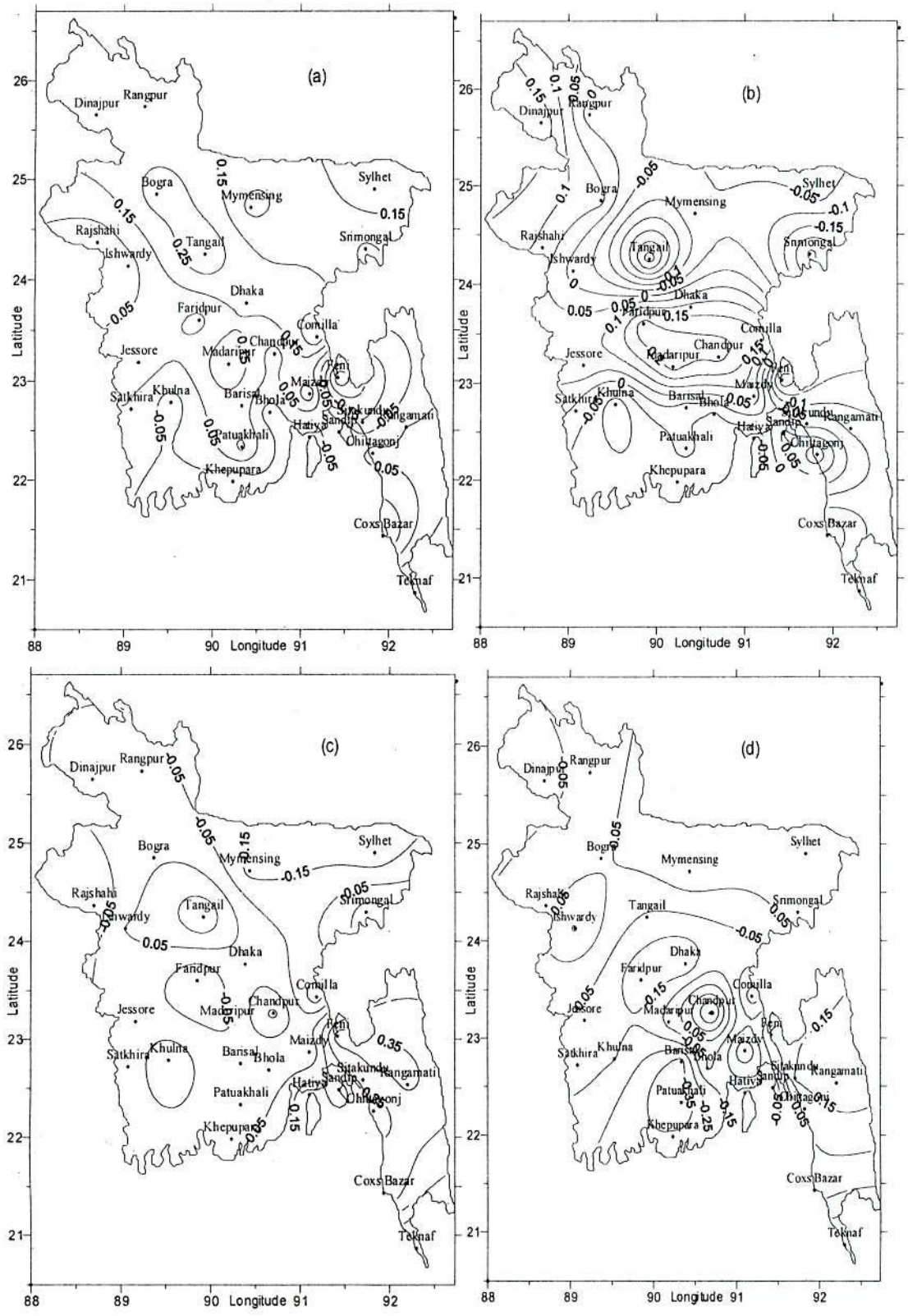


Fig 3.4.3(a-d): Correlation coefficients between Post-monsoon rain and WBT & DBT of June, July, August and September respectively

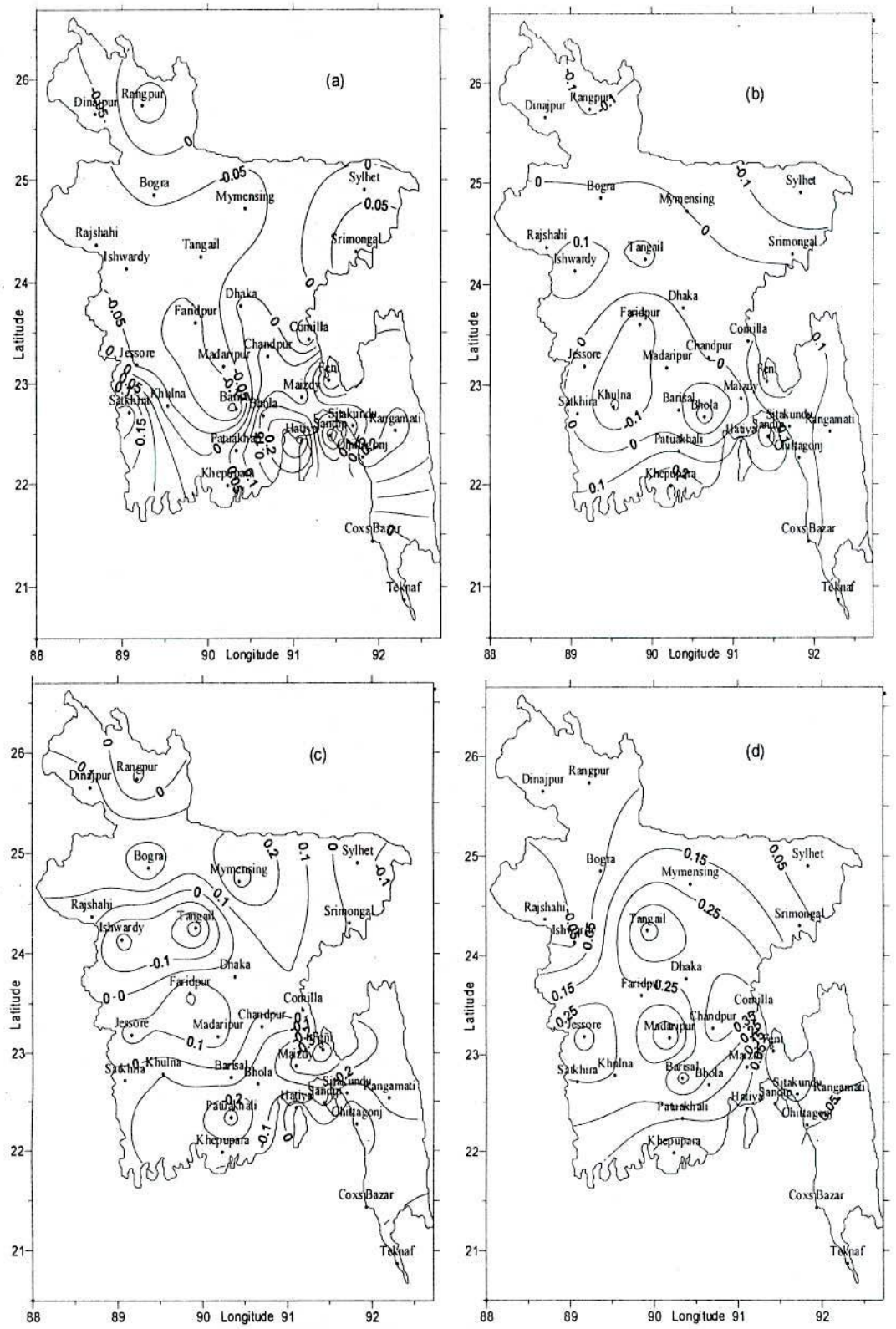


Fig 3.4.4(a-d): Correlation coefficients between October rainfall and WBT & rainfall of June, July, August and September respectively

is positive all over the country except Dinajpur, Mymensing, Barisal, Madaripur, Faridpur and Jessore region. The maximum negative and positive CC are observed at Barisal and Hatiya and are -0.15 and 0.30 respectively.

July: The distribution of CC between rainfall of October and WBT & rainfall July all over the country is shown in Fig 3.4.4 (b). The distribution pattern shows that the CC are positive all over the country except Rangpur, Sylhet, Khulna, Faridpur, Barisal and Bhola region. The maximum negative and positive CC is observed at Bhola and Khepupara and are -0.20 and 0.30 respectively. Over most of the regions of the country the CC is zero.

August: The distribution of the CC between the rainfall of October and WBT & rainfall of August all over Bangladesh is shown in fig 3.4.4 (c). From the distribution shows that the CC is negative over Tangail, Sylhet, Ishwardy and southern side of the country. The maximum negative and positive CC are observed at Feni and Mymensing region and are -0.4 and 0.3 respectively.

September: The distribution of the CC between the rainfall of October and WBT &rainfall of September all over Bangladesh is shown in Fig 3.4.4 (d). From the distribution pattern we observe that the CC is positive all over the country except Ishwardy where its value is -0.05. The maximum positive CC is observed at Tangail and Madaripur and is 0.45. The next highest CC is observed at Jessore, Comilla, Chandpur and Barisal region. The CC at Tangail and Madaripur is significant at 95 % level.

3.4.5 Distribution of CC between November rainfall and WBT & rainfall of June, July, August and September

June: The distribution of CC between the rainfall of November and WBT & rainfall of June all over the country is shown in fig 3.4.5 (a). The distribution shows that the CC is positive all over the country except Mymensing, Rajshahi, Dhaka, Chittagong and Hatiya region where its value is –0.05. The maximum positive CC is observed at Dinajpur region and is 0.45. The CC is significant at 99% level at Dinajpur.

July: The distribution of CC between rainfall of November and WBT & rainfall of July all over Bangladesh is shown in Fig 3.4.5 (b). The distribution pattern shows that the CC is positive all over the country except Sylhet, Srimongal and Patuakhali. The

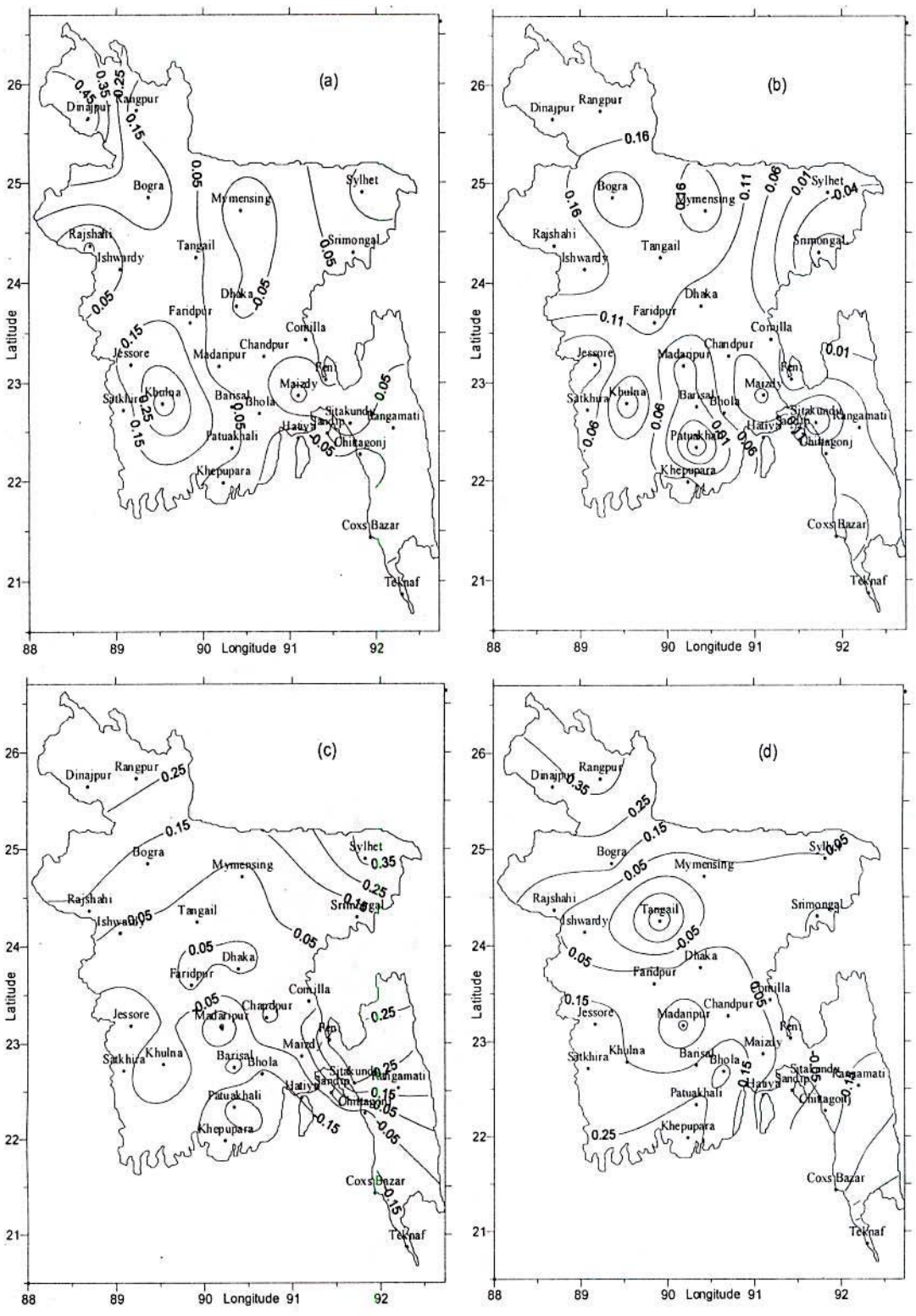


Fig 3.4.5(a-d): Correlation coefficients between November rainfall and WBT & rainfall of June, July, August and September respectively

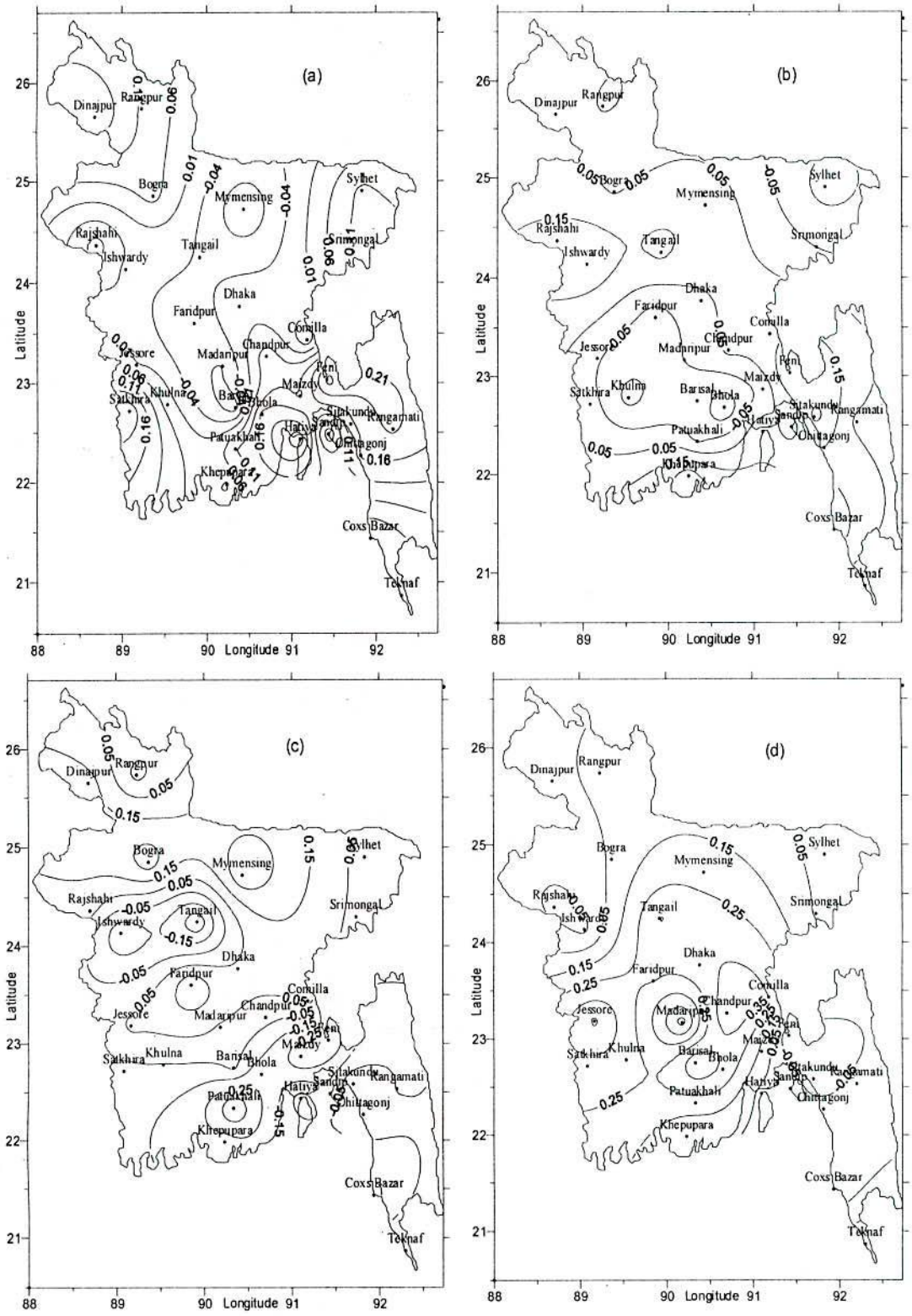


Fig 3.4.6(a-d): Correlation coefficients between Post-monsoon rainfall and WBT & rainfall of June, July, August and September respectively

maximum positive and negative CC are observed at Bogra and Patuakhali and are 0.21 and –0.11 respectively.

August: Fig 3.4.5 (c) shows the distribution of CC between the rainfall of November and WBT & rainfall of August all over Bangladesh. From the figure we observe that the CC is positive all over the country except the southern region i.e.coastal area of the country. The maximum negative and positive CC are observed at Patuakhali and Sylhet region and are -0.25 and 0.35 respectively. From the analysis we have observed that the CC between November rainfall and WBT & rainfall of August are positively correlated in most of the regions of the country.

September: Fig 3.4.5 (d) shows the distribution of CC between the rainfall of November and WBT & rainfall of September all over the country. The distribution shows that the CC is positive all over the country except Tangail, Chittagong, Rangamati and Sitakundu region. The maximum negative and positive CC are observed at Tangail and Rangpur region and its value are -0.25 and 0.35 respectively.

3.4.6 Distribution of CC between Post-monsoon Rainfall and WBT & rainfall of June, July, August and September

June: The distribution of CC between the rainfall of Post-monsoon and WBT & rainfall of June all over the country is shown in fig 3.4.6 (a). Here we observe that the CC is positive all over the country except Mymensing, Tangail, Faridpur, Madaripur and Barisal region. The maximum positive CC is observed at Feni and Hatiya and negative CC is observed at Barisal and Mymensing region and its value are 0.26 and –0.09 respectively.

July: The distribution of the CC between the rainfall of Post-monsoon and WBT & rainfall of July all over Bangladesh is shown in Fig 3.4.6 (b). From the figure we observe that the CC is positive all over the country except Rangpur, Sylhet, Srimongal, Satkhira, Jessore, Patuakhali, Bhola, Khulna, Faridpur and Madaripur region. The maximum negative CC is observed at Sylhet, Khulna and Bhola region and maximum positive CC is observed at Khepupara and Sitakundu region and are -0.15 and 0.25 respectively.

August: The distribution of the CC between the rainfall of Post-monsoon and WBT & rainfall of August all over Bangladesh is shown in Fig 3.4.6 (c). The distribution

shows that the CC is negative in the southern side and Tangail, Ishwardy region. The maximum

negative CC is observed at Patuakhali and maximum positive CC is observed at Bogra, Mymensing region and are –0.35 and 0.25 respectively. The next negative CC is observed at Tangail, Khepupara, Hatiya, Maizdy-court and Cox's Bazar region and its value is –0.25. It is also observed that over the maximum regions of the country the CC lies between –0.05 to 0.05. The CC in Patuakhali region is significant in 95% level.

September: The distribution of the CC between the rainfall of Post-monsoon WBT & rainfall of September all over Bangladesh is shown in Fig 3.4.6 (d). The distribution shows that the CC is positive all over the country except Feni, Sitakundu and Rangamati region where is -0.05. The maximum positive CC is observed at Madaripur region and is 0.55. The next highest positive CC is observed at Jessore region and its value is 0.45. The CC at Madaripur region is significant in 99% level.

3.4.7 Distribution of CC among the WBT, DBT and Rainfall of June, July, August and September

June: The distribution of CC among the WBT, DBT and Rainfall of June all over Bangladesh is shown in Fig 3.4.7 (a). The distribution shows that the CC is negative all over the country except Sylhet, Mymensing, Chandpur and Hatiya region where the CC is 0.15. The maximum negative CC is observed at Rangamati, Comilla and Cox's Bazar region and is -0.55. The CC in Cox's Bazar region is significant in 99% level.

July: The distribution of CC among the WBT, DBT & Rainfall of July all over Bangladesh is shown in Fig 3.4.7 (b). It is seen that CC is negative all over the country except Sylhet, Mymensing and Ishwardy region. The maximum negative CC is observed at Rangpur, Feni, Dhaka, Faridpur and Tangail region and is -0.45. It is significance at 99% level. The maximum positive CC is observed at Mymensing and is 0.25 is significant is at 95% level.

August: Fig 3.4.7 (c) represents the CC among WBT, DBT and Rainfall of August all over Bangladesh. The distribution shows that the CC is negative all over the country except Jessore, Satkhira region. The maximum negative and positive CC are observed at Tangail and Jessore and are -0 .55 and 0.25 respectively. The CC at Tangail and Jessore region is significant at 95% level.

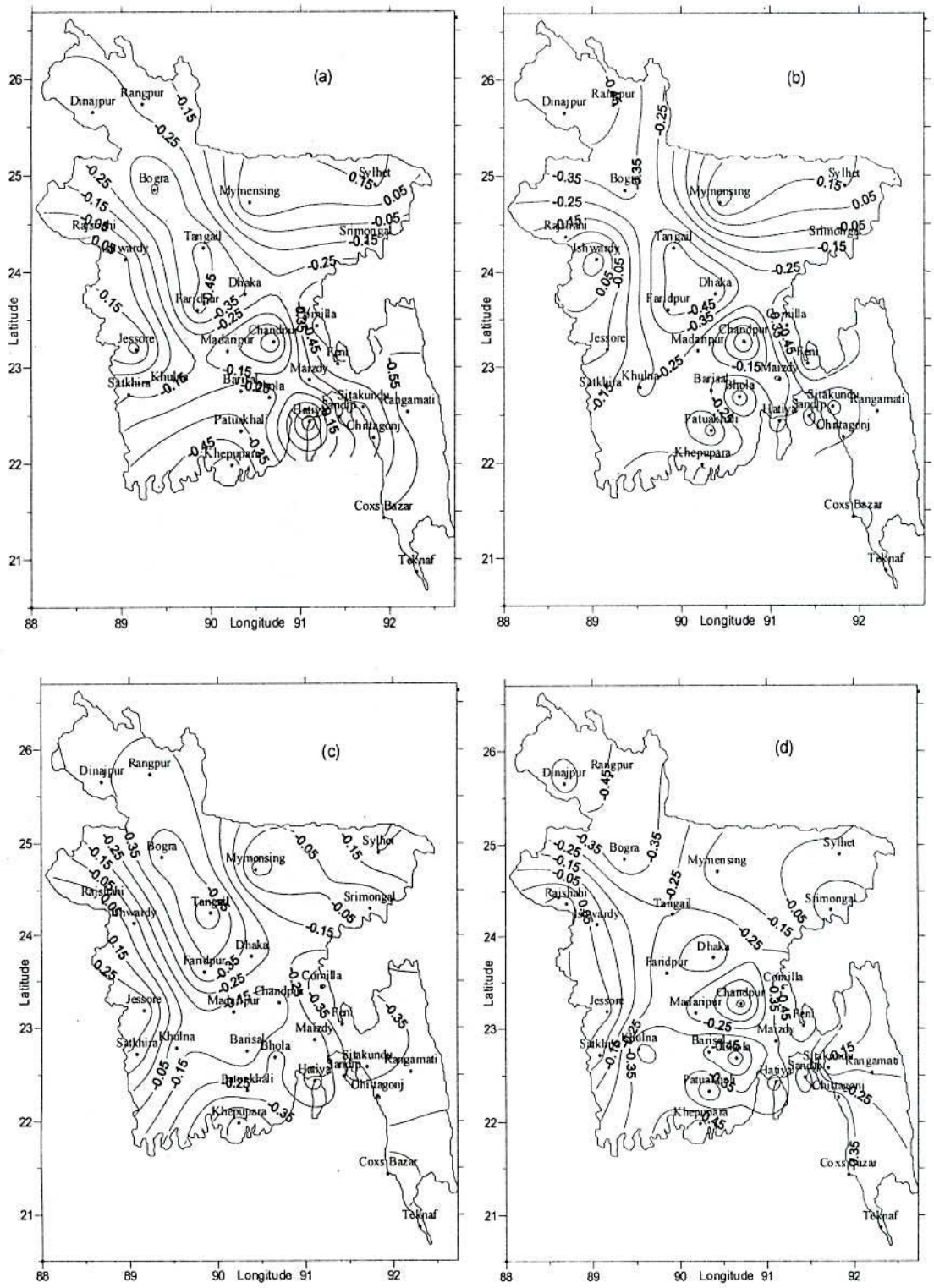


Fig 3.4.7(a-d): Correlation coefficients among the WBT, DBT and rainfall of June, July, August and September respectively

September: The distribution of the CC among WBT, DBT and Rainfall of August all over Bangladesh is shown in Fig 3.4.7 (d). The distribution patterns shows that the CC is negative all over the country except Jessore, Ishwardy, Rajshahi, Chandpur and Srimongal region. The maximum negative and positive CC are observed at Dinajpur and Rajshahi and are -0.55 and 0.15 respectively. The CC in Dinajpur is significance in 99% level.

3.4.8 Distribution of CC between WBT & DBT of monsoon and the rainfall of October, November and Post-monsoon

October: Fig 3.4.8 (a) shows that the distribution of CC between WBT & DBT of monsoon and October rainfall all over Bangladesh. The distribution pattern shows that the CC is positive all over Bangladesh. The CC are comparatively very low. The maximum positive CC is observed at Tangail and Feni and is 0.17. The next highest CC is observed at Patuakhali and is 0.15. The lowest CC is observed at Rangpur, Mymensing and Sylhet region and is 0.01. From the analysis we observed that the WBT & DBT of monsoon and October rainfall are positively correlated.

November: The distribution of CC between the WBT & DBT of monsoon November rainfall all over Bangladesh is shown in Fig 3.4.8 (b). We observe that the CC is positive all over the country. The maximum positive CC is observed at Sitakundu region and is 0.40. Over maximum regions of the country the CC is about 0.05. Thus the WBT & DBT of monsoon and November rainfall are positively correlated. The CC at Dinajpur is significant at 95%level.

Post-monsoon: Fig 3.4.8 (c) shows that the distribution of CC between the WBT & DBT of monsoon and rainfall of Post-monsoon all over Bangladesh. From the distribution pattern we observe that the CC is positive all over the country. The maximum CC is observed at Feni and is 0.17. The lowest CC is observed at Mymensing, Sylhet, Satkhira, Khulna and Khepupara region. We also observe that the CC gradually increases towards the eastern and western side and decrease in the southwestern and northeastern side from the central region. From this analysis we can say that

The WBT & DBT of October, November and Post-monsoon season are positively correlated.

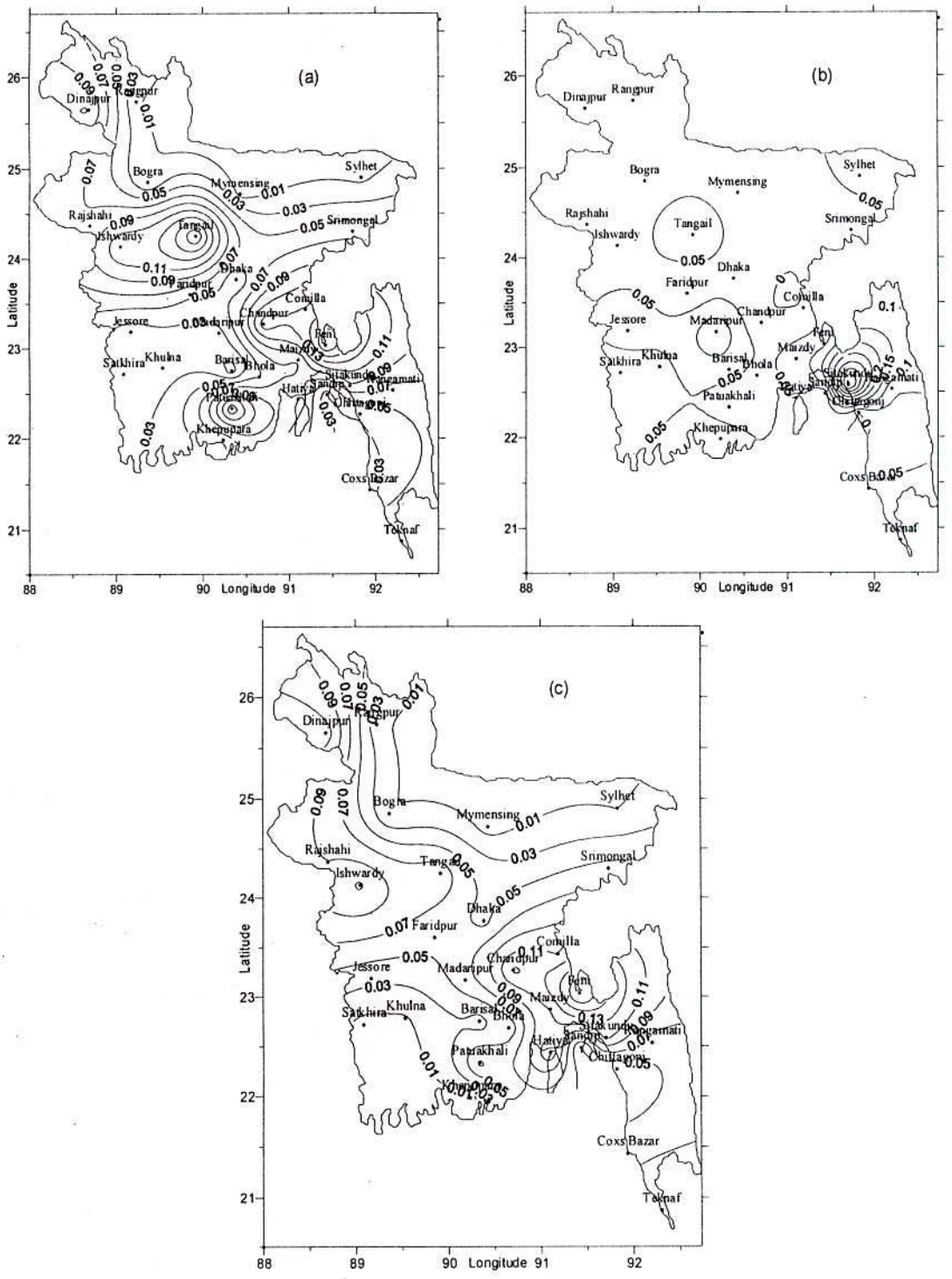


Fig 3.4.8(a-c): Correlation coefficients between WBT & DBT of monsoon and the rainfall of October, November and Post-monsoon respectively

3.4.9 Distribution of CC between the rainfall of October, November and Post-monsoon and rainfall & WBT of monsoon

October: Fig 3.4.9 (a) shows the distribution of CC between October rainfall and rainfall and WBT of monsoon all over Bangladesh. The distribution shows that the CC is positive all over the country except Srimongal, Patuakhali, Khepupara, Feni, Maizdy-court and Sitakundu region. The CC are comparatively low. The maximum positive and negative CC are observed at Khulna and Feni and are 0.25 and –0.30 respectively. Over maximum regions the CC lies between 0 to 0.1. The CC is significance 95% in Khulna and Feni region.

November: The distribution of CC between the rainfall of November and rainfall & WBT of monsoon all over Bangladesh is shown in Fig 3.4.9 (b). The distribution pattern we shows that the CC is positive all over the country except Hatiya, Madaripur, Patuakhali, Maizdy-court, Sitakundu, Sandip and Cox's Bazar region. The maximum positive and negative CC are observed at Bogra and Sitakundu and are 0.40 and –0.20 respectively. The rainfall of November and rainfall and WBT of monsoon are positively correlated in most of the regions. The CC at Bogra region is significant at 99% Level.

Post-monsoon: Fig 3.4.9 (c) shows that the distribution of CC between Post-monsoon rains and rainfall & WBT of monsoon all over Bangladesh. From the figure we observe that the CC is positive all over the country except Feni, Maizdy-court, and Sitakundu and Patuakhali region. The maximum negative and positive CC are observed at Feni and Khulna and are-0.20 and 0.25 respectively.

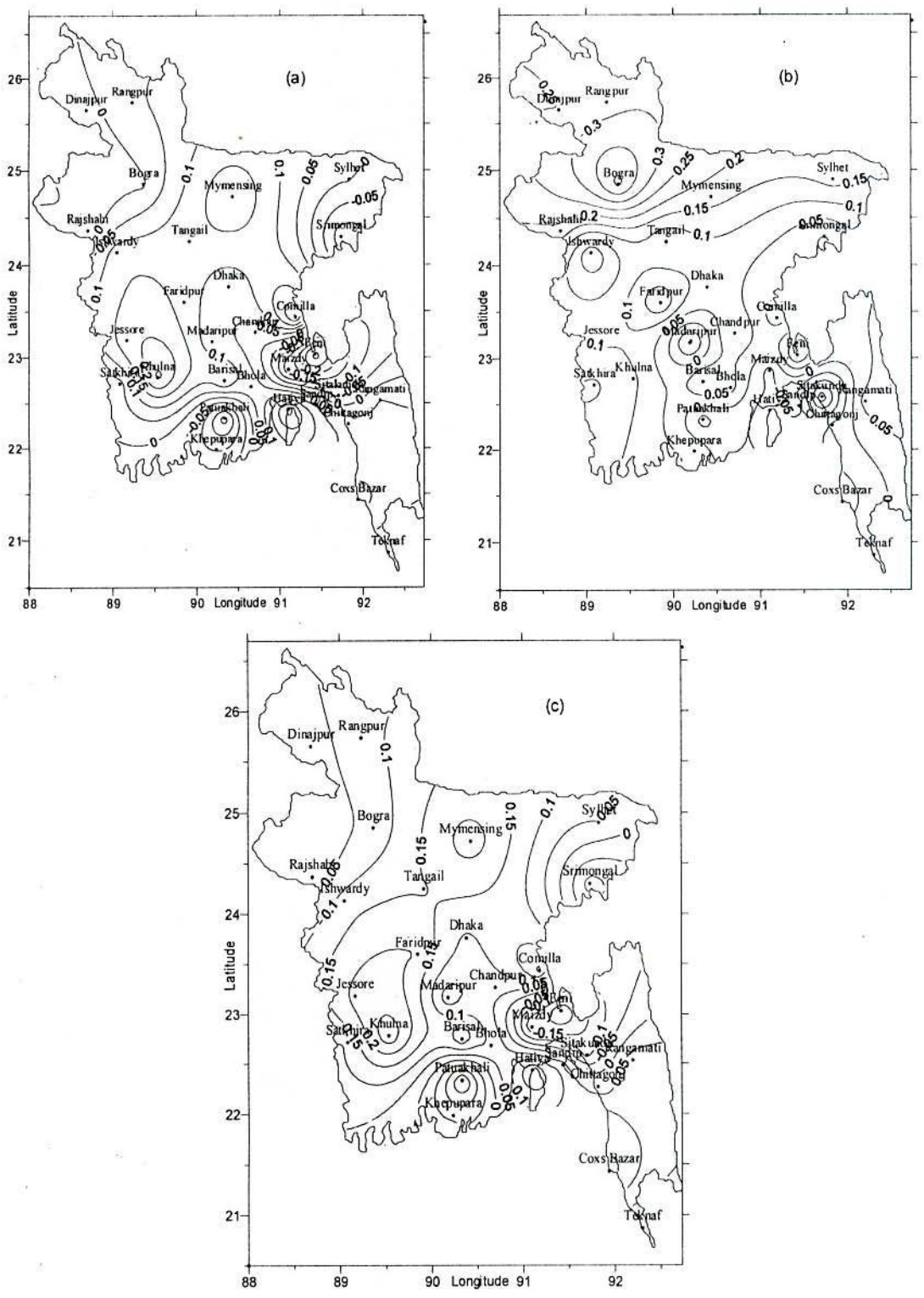


Fig 3.4.9(a-c): Correlation coefficients between the rainfall of October, November and Post-monsoon and rainfall & WBT of monsoon respectively

3.5 Correlation Coefficients between rainfall of Post-monsoon and 3 parameters of monsoon

3.5.1 Distribution of CC between October rainfall and WBT, DBT & Rainfall of June, July, August and September

June: Fig 3.5.1 (a) represents the CC between rainfall of October and WBT, DBT & Rainfall of June all over Bangladesh. The maximum CC observed at Tangail and is 0.40. The next highest CC is observed at Feni and its value is 0.30. We also observed that over most of the regions of the country the CC lies between 0.05 to 0.10. From the analysis we can say that the rainfall of October and WBT, DBT & rainfall of June are positively correlated. The CC at Tangail region is significant about 95% level.

July: The distribution of CC between rainfall of October and WBT, DBT & rainfall of July all over Bangladesh is shown in Fig 3.5.1 (b). The distribution pattern shows that the CC is positive all over the country. The maximum positive CC is observed at Tangail and is 0.23. The next highest CC is observed at Chandpur and its value is 0.13. We also observed over most of that the maximum region of the country the CC is 0.03.

August: Fig 3.5.1 (c) shows that the distribution of CC between rainfall of October and WBT, DBT & rainfall of August all over Bangladesh. The maximum positive CC is observed at Tangail and is 0.30. The next highest CC is observed at Patuakhali and Feni and its value is 0.25. The lowest CC is observed at Cox's Bazar, Sandip, Bhola, Comilla, Dhaka, Srimongal and Rangpur region and its value is 0.05.

September: Fig 3.5.1 (d) shows that the distribution of CC between rainfall of October and WBT, DBT & rainfall of September all over Bangladesh. From the figure we observe that the CC is positive all over the country. The maximum positive CC is observed at Chandpur and is 0.30. The next highest CC is observed at Tangail and its value is 0.25. The CC in Chandpur region is significant in 95% level.

3.5.2 Distribution of CC between November rainfall and WBT, DBT & Rainfall of June, July, August and September

June: The distribution of CC between rainfall of November and WBT, DBT & rainfall of June all over Bangladesh is shown in Fig 3.5.2 (a). From the distribution pattern we observe that the CC is positive all over the country. The maximum positive CC is observed at Sitakundu and is 0.35. The next positive CC is observed at Tangail and its

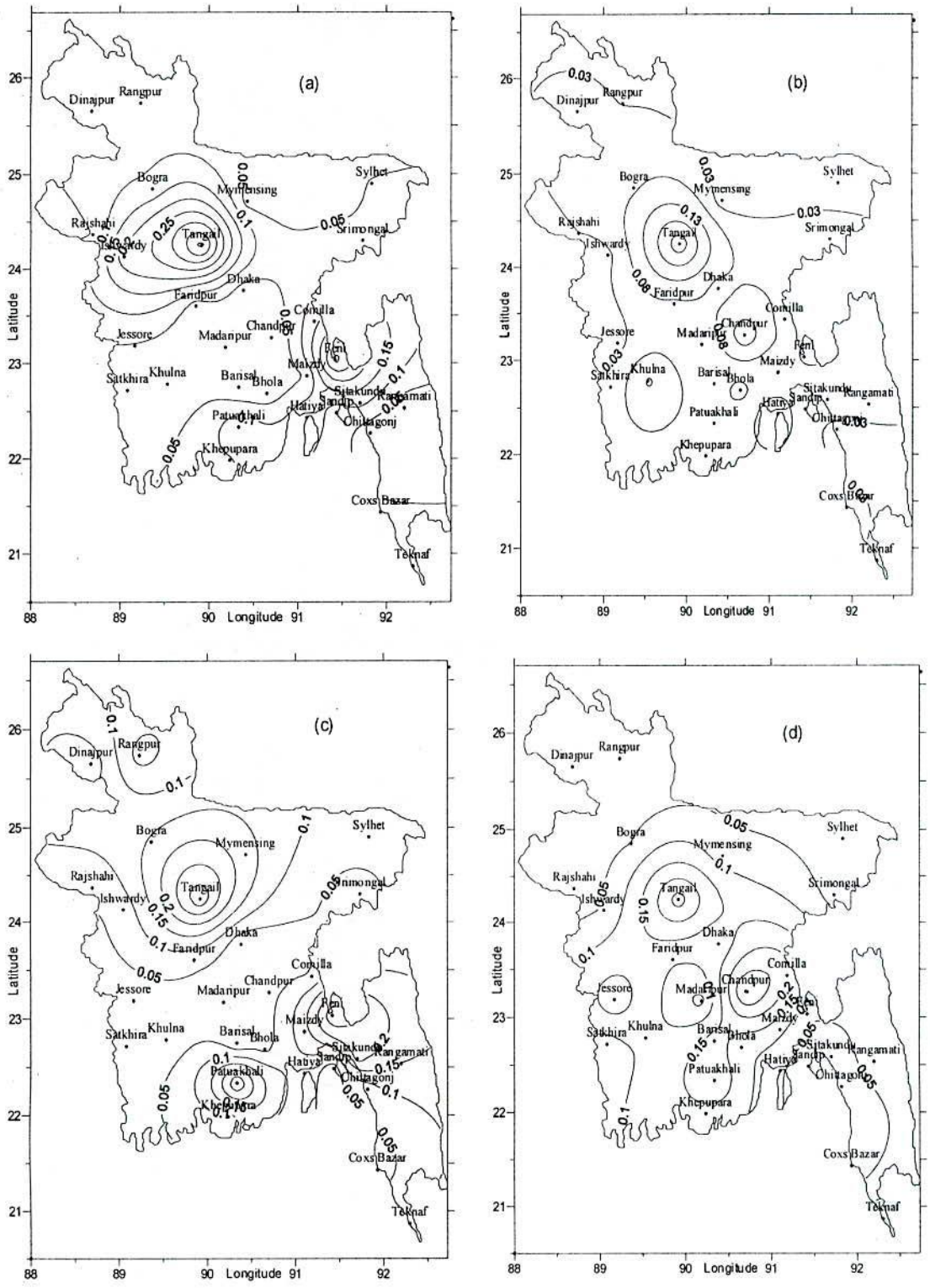


Fig 3.5.1(a-d): Correlation coefficients between October rainfall and WBT, DBT & rainfall of June, July, August and September respectively

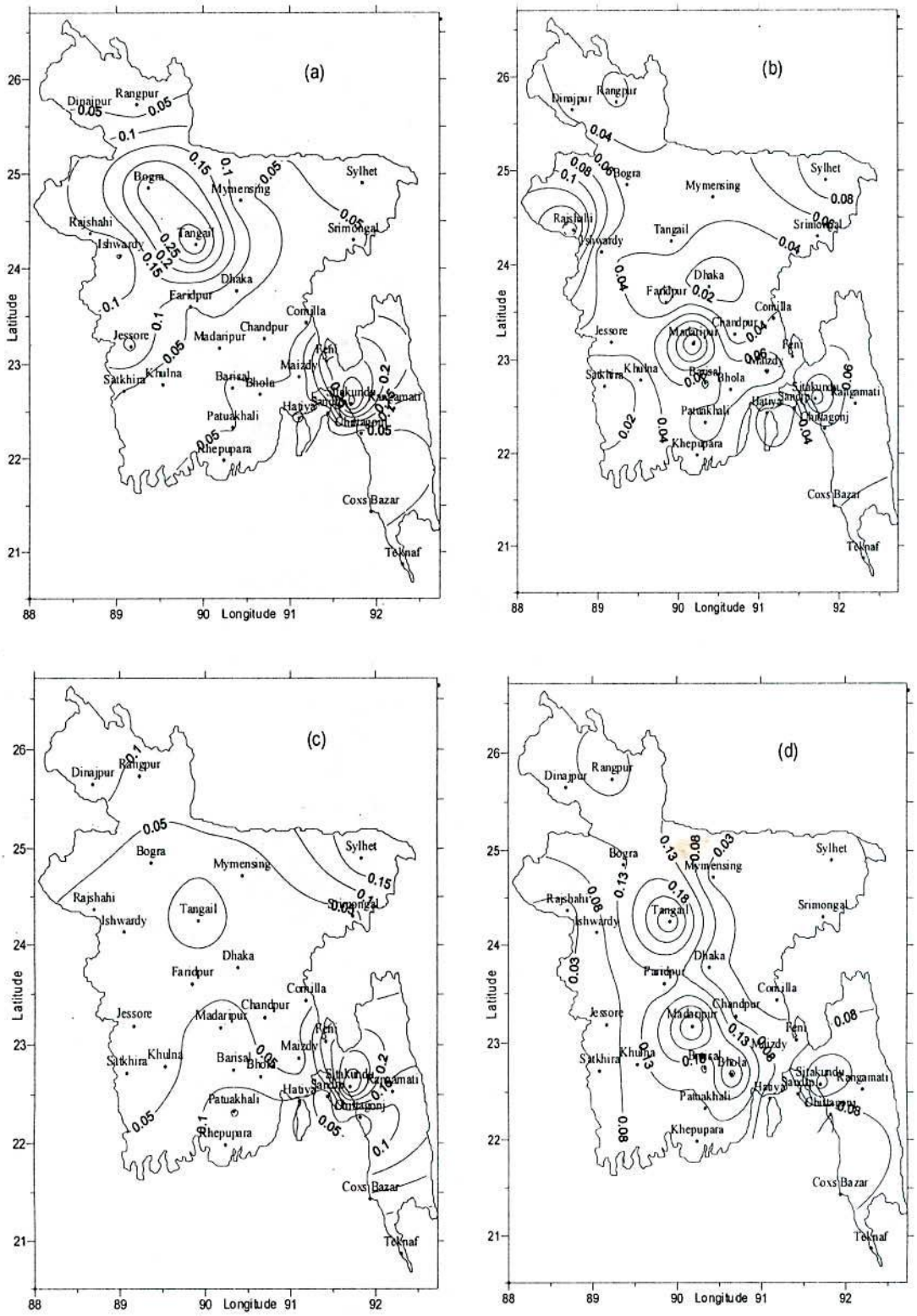


Fig 3.5.2(a-d): Correlation coefficients between November rainfall and WBT, DBT & rainfall of June, July, August and September respectively

value is 0.30. The CC is only 0.05over most of the regions of the country. The CC in Tangail region is significant at 90% level.

July: The Fig 3.5.2 (b) represents the CC between rainfall of November and WBT, DBT & rainfall of July all over Bangladesh. From the distribution pattern we observed that the CC is comparatively low in this case and is positive all over the country. The maximum positive CC is observed at Rajshahi region and is 0.16. Thus when WBT, DBT and rainfall of July will increase then the rainfall of November will also increase.

August: The distribution of CC between Rainfall of November and WBT, DBT & rainfall of August all over the country is shown in Fig 3.5.2 (c). The distribution shows that the CC is positive all over country. The maximum positive CC is observed at Sitakundu region and is 0.30. The CC in Sitakundu region is significant in 90% level.

September: The distribution of CC between the rainfall of November and WBT, DBT & Rainfall of September all over Bangladesh is shown in Fig 3.5.2 (d). The distribution pattern shows that the CC is positive all over the country. The maximum positive CC is observed at Tangail and Madaripur region and is 0.28. The CC is significant above 90% level in Tangail and Madaripur region. From the above discussions we may conclude that there is a positive correlation between November rainfall and WBT, DBT & rainfall of all the months of monsoon.

3.5.3 Distribution of CC between Post-monsoon rainfall and WBT, DBT & rainfall of June, July, August and September

June: Fig 3.5.3 (a) represents the distribution of the CC between the rainfall of Post-monsoon and WBT, DBT & rainfall of June over Bangladesh. From the figure we observe that the CC is positive all over the country. The maximum positive CC is observed at Tangail and is 0.35. The lowest positive CC is observed at Faridpur, Dhaka, Bhola, Patuakhali, Khepupara, Rangamati, Chittagong region and its value is 0.05.

July: The distribution of the CC between the Post-monsoon rainfall and with WBT, DBT & rainfall of July all over Bangladesh is shown in Fig 3.5.3 (b). The distribution pattern shows that the CC is positive all over the country and though values are comparatively low. The maximum positive CC is observed at Tangail and is 0.18. The next positive CC observed at Khulna and its value is 0.12. The lowest positive CC observed at Mymensing, Sylhet, Rajshahi, Jessore region and its value only 0.02. Thus we can say that the rainfall of post-

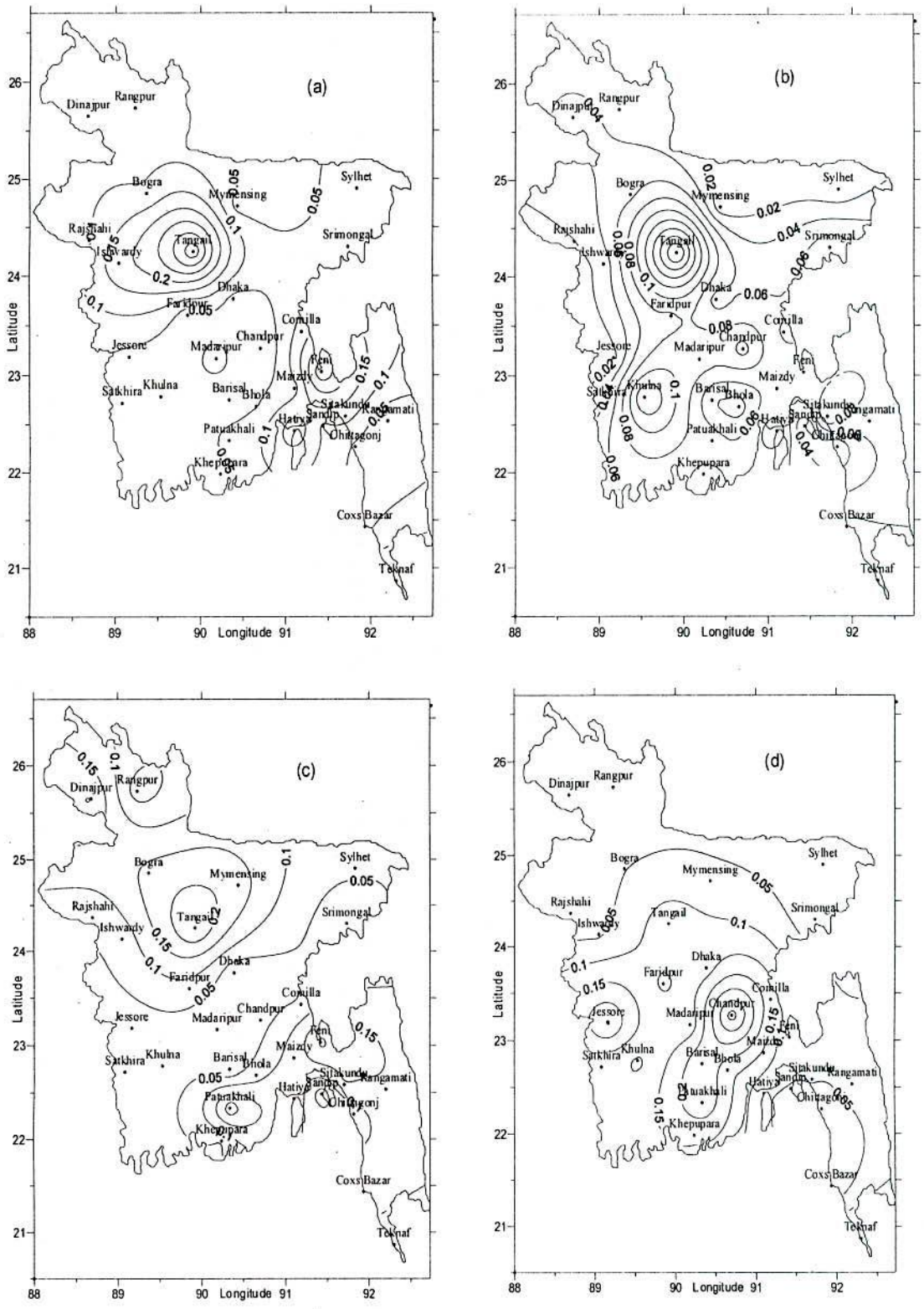


Fig 3.5.3(a-d): Correlation coefficients between Post-monsoon rainfall and WBT, DBT & rainfall of June, July, August and September respectively

monsoon and WBT, DBT & Rainfall of July are positively correlated.

August: Fig 3.5.3 (c) shows that the distribution of CC between the rainfall of post moon season and WBT, DBT & rainfall of August all over Bangladesh. From the figure we observe that the CC is positive all over the country. The maximum positive CC is observed at Tangail region and is 0.25. Thus with the increase in the WBT, DBT, and rainfall of August the rainfall of Post-monsoon will also increase.

September: The distribution of CC between rainfall of Post-monsoon season and WBT, DBT & rainfall of September all over Bangladesh is shown in Fig 3.5.3 (d). Here we observe that the CC is positive all over the country. The maximum positive CC is observed at Chandpur and is 0.35. The CC in Chandpur region is significant above 95% level.

From the above discussions we may conclude that the rainfall of Post-monsoon is positively correlated with the WBT, DBT & rainfall of all month of monsoon it with the increase in WBT, DBT & rainfall of any month of monsoon the rainfall of Post-monsoon will increase.

3.5.4 Distribution of CC between DBT, WBT & rainfall of monsoon and the rainfall of October, November and Post-monsoon

October: The distribution of CC between DBT, WBT & rainfall of monsoon and rainfall of October all over Bangladesh is shown Fig 3.5.4 (a). The distribution pattern shows that the CC is positive all over the country. The maximum positive CC is observed at Feni and is 0.20. Thus it there is increase in the WBT, DBT, Rainfall of monsoon then the rainfall of October will also increase.

November: Fig 3.5.4 (b) shows the distribution of CC between the monsoon of DBT, WBT, & Rainfall of monsoon and Rainfall of November all over Bangladesh. The distribution pattern shows that the CC is positive all over the country. The maximum positive CC is observed at Sitakundu and is 0.45. Over most of the regions the CC is only 0.05. The CC in Sitakundu is significant in 99% level.

Post-monsoon: The distribution of CC between DBT, WBT & rainfall of monsoon and rainfall of Post-monsoon season all over Bangladesh is shown in Fig 3.5.4 (c). The distribution pattern shows that the CC is positive all over the country. The maximum positive CC is observed at Feni and is 0.18.

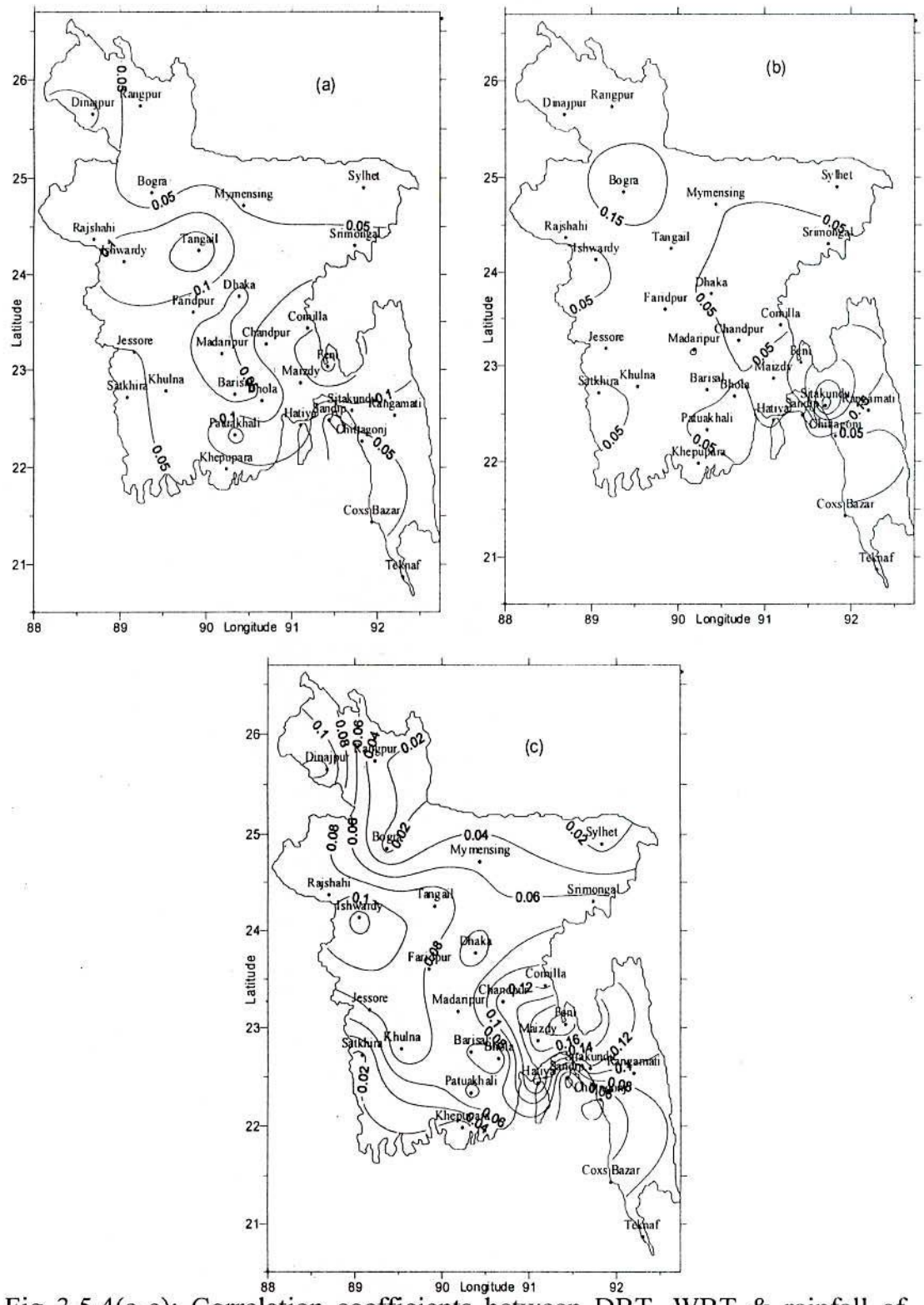


Fig 3.5.4(a-c): Correlation coefficients between DBT, WBT & rainfall of monsoon and the rainfall of October, November and Post-monsoon respectively

3.6 CC between DBT, WBT & rainfall of different regions of monsoon and the rainfall of October, November and Post-monsoon

We have divide the Country into two regions, namely dry region and wet region on the basis of monsoon rainfall. Out of 30 stations 20 stations fall in the wet region and 10 stations fall in the dry regions. At first we averaging the DBT, WBT, Rainfall of different months of monsoon season and rainfall of post-monsoon season in the wet region, dry region and country wise. Then we try to calculate the value of CC between DBT, WBT and Rainfall of different months of monsoon and season itself in the dry, wet region and country itself with the rainfall of October, November and post-monsoon itself. The month and season wise CC is plotted in the bar diagram.

From Fig. 3.6.1(a-c) the maximum CC is observed for the DBT of September with the rainfall of October, November and post-monsoon in the dry region, wet region and country as a whole. From Fig. 3.6.2(a-c) the maximum CC is observed for the WBT of September with the rainfall of post-monsoon in the dry region. The figure also shows that the maximum CC is found for the WBT of June with the rainfall of November in the wet region and country as a whole. The maximum CC is observed for the average rainfall of monsoon season with the rainfall of November in the dry region.

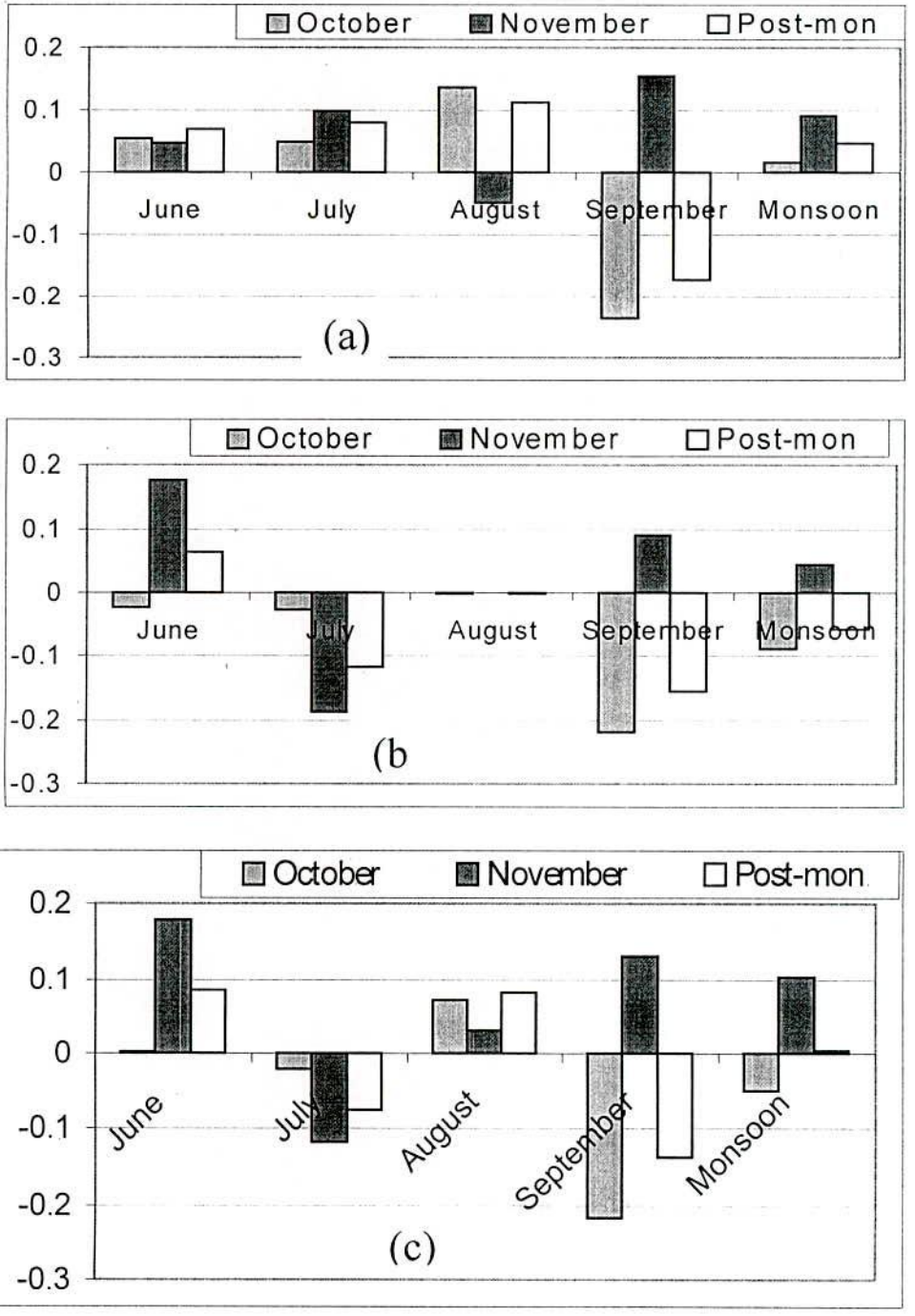


Fig. 3.6.1 (a-c): Correlation between Monsoon DBT Vs. Post-monsoon rainfall for a) Dry region, b) Wet region and c) All over the Country

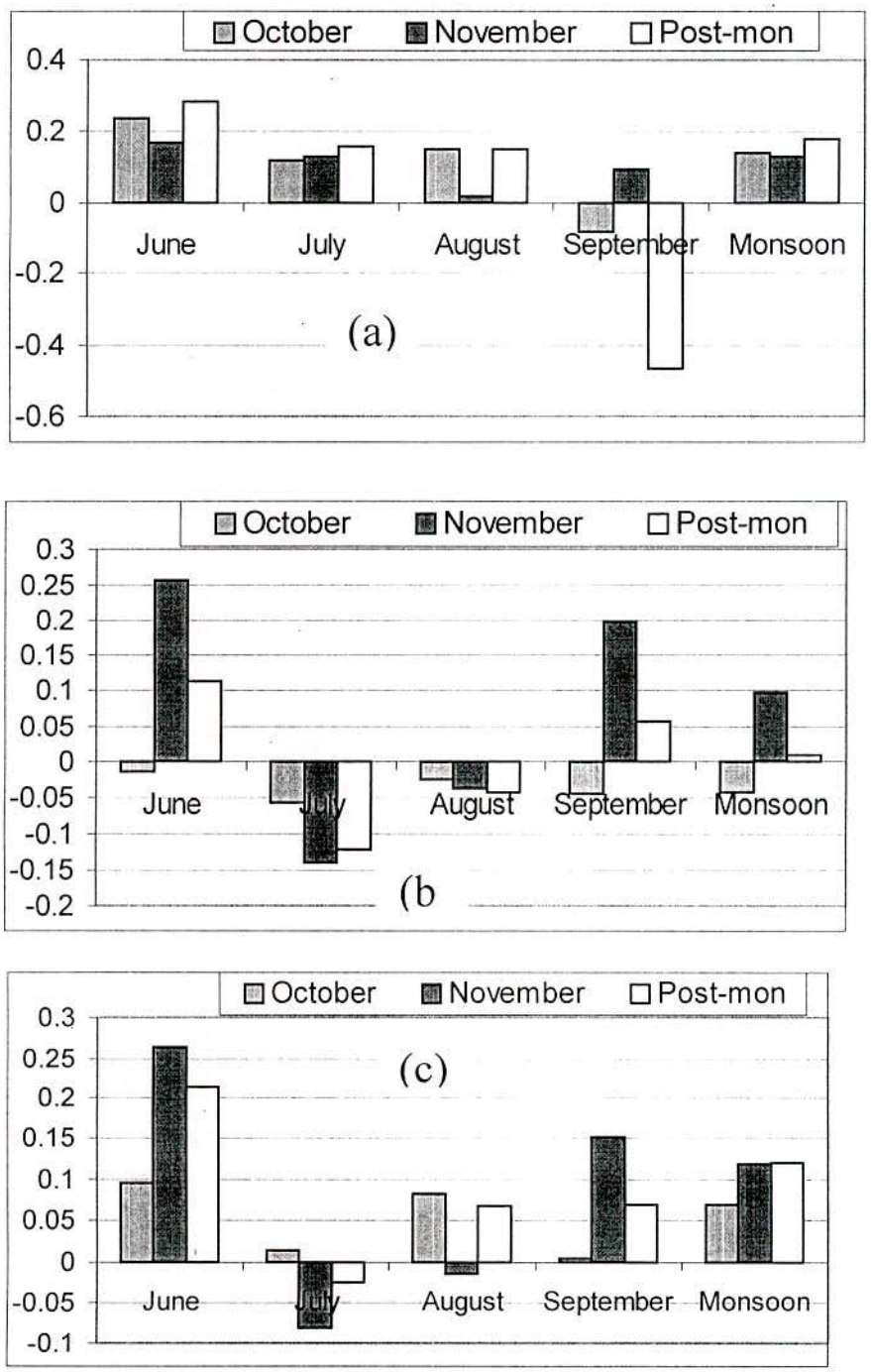
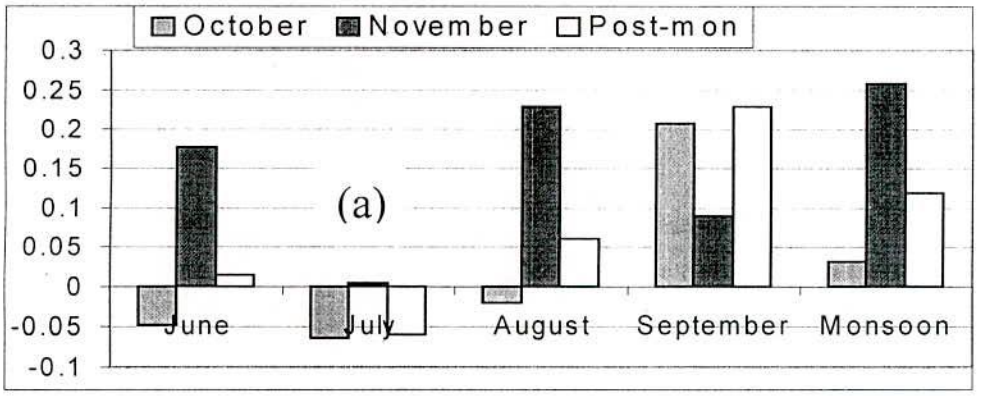
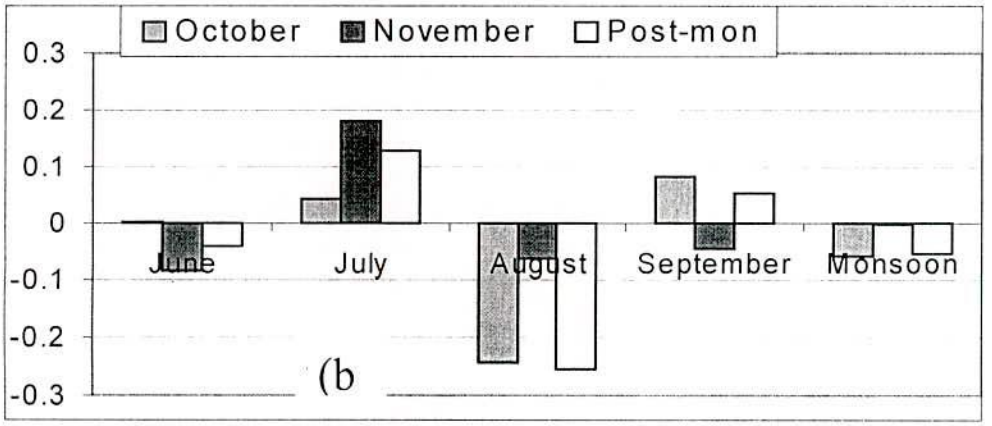


Fig. 3.6.2 (a-c): Correlation between Monsoon WBT Vs. Post-monsoon rainfall for a) Dry region, b) Wet region and c) All over the Country





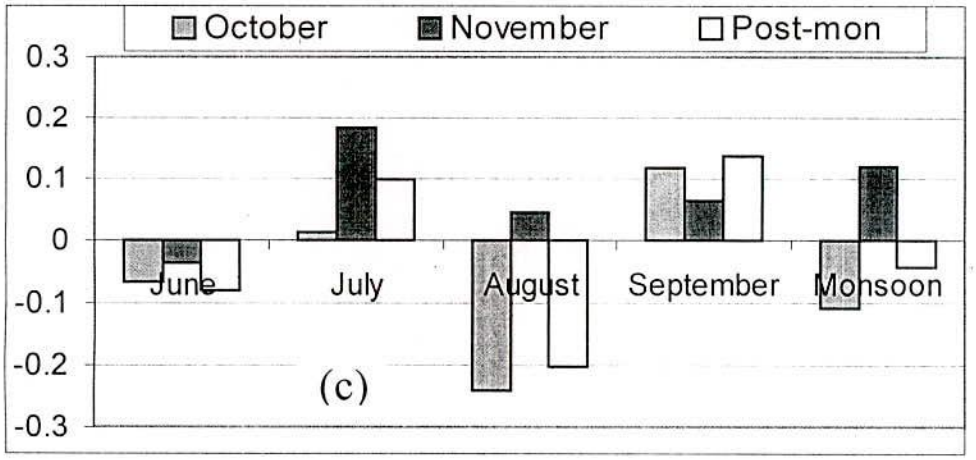


Fig. 3.6.3 (a-c): Correlation between Monsoon Rainfall Vs. Post-monsoon rainfall for a) Dry region, b) Wet region and c) All over the Country

3.7 Regression Equations

Regression equations for all the stations under consideration have been developed considering rainfall of October and November as dependent variable depending on the rainfall, DBT and WBT of monsoon by using *Instat+* (a statistical software). The equations are tabulated in the following table.

Name of the Station	Regression Equations
Satkhira	$R_O = 0.0072R_M - 4.2749D_M - 1.012W_M + 724.28$ $R_N = 0.0281R_M + 0.9463D_M + 3.3719W_M - 477.00$
Khulna	$R_O = 0.0589R_M - 0.0236D_M - 8.9392W_M + 1019.30$ $R_N = 0.0215R_M + 7.9597D_M - 1.0011W_M - 800.44$
Barisal	$R_O = 0.0518R_M - 1.2831D_M + 5.869W_M - 374.87$ $R_N = 0.0187R_M - 15.472D_M + 22.646W_M - 658.66$
Bhola	$R_O = 0.0113R_M - 37.822D_M + 21.436W_M + 2109.90$ $R_N = 0.0479R_M + 6.6491D_M - 32.772W_M + 2742.80$
Maizdy court	$R_O = -0.0815R_M - 54.626D_M + 50.164W_M + 1243.00$ $R_N = -0.0171R_M - 24.676D_M + 31.952W_M - 500.62$
Patuakhali	$R_O = -0.0188R_M - 30.805D_M + 10.579W_M + 2571.10$ $R_N = -0.0187R_M + 5.4287D_M + 0.9287W_M - 608.88$
Hatiya	$R_O = 0.0628R_M + 34.09D_M + 12.523W_M - 5047.20$ $R_N = -0.0163R_M + 15.201D_M + 1.0998W_M - 1715.20$
Sandip	$R_O = 0.0277R_M + 12.043D_M + 5.38W_M - 1777.30$ $R_N = -0.0039R_M - 5.6135D_M + 11.372W_M - 510.28$
Sitakundu	$R_O = 0.0009R_M + 55.392D_M - 68.073W_M - 68.07$ $R_N = -0.0227R_M + 4.5379D_M + 52.784W_M - 5917.20$
Rangamati	$R_O = 0.0346R_M + 33.34D_M - 61.581W_M + 2739.50$ $R_N = 0.0182R_M + 14.183D_M - 8.2453W_M - 703.56$
Chittagong	$R_O = 0.0190R_M + 8.9018D_M + 9.407W_M - 1807.10$ $R_N = -0.0065R_M + 1.8657D_M + 0.1358W_M - 154.37$
Khepupara	$R_O = -0.0460R_N + 38.328D_M - 40.89W_M + 343.00$ $R_N = 0.0066R_M - 44.872D_M + 47.058W_M + 105.33$
Cox's Bazar	$R_O = 0.0169R_M + 24.821D_M - 42.874W_M + 1912.90$ $R_N = 0.0038R_M + 36.015D_M - 33.731W_M - 391.08$

Name of the Station	Regression Equations
Teknaf	$R_O = 0.0130R_M - 48.028D_M + 26.722W_M + 2697.90$ $R_N = 0.0120R_M + 19.255D_M + 15.906W_M - 3758.20$
Srimongal	$R_O = -0.0383R_M + 12.253D_M - 20.675W_M + 1007.60$ $R_N = -0.0007R_M + 0.4021D_M - 2.1184W_M + 214.04$
Dhaka	$R_O = 0.00566R_M - 17.356D_M + 38.879W_M - 1979.70$ $R_N = 0.0180R_M + 4.3232D_M + 2.2587W_M - 724.35$
Faridpur	$R_O = 0.0375R_M - 31.627D_M + 43.239W_M - 898.70$ $R_N = 0.0354R_M + 4.7997D_M - 2.6713W_M - 275.41$
Comilla	$R_O = 0.0310R_M - 25.058D_M + 24.928W_M + 310.33$ $R_N = -0.0095R_M - 4.6826D_M + 1.7931W_M + 393.97$
Jessore	$R_O = 0.0546R_M + 5.3341D_M + 4.7753W_M - 1067.00$ $R_N = 0.0174R_M - 6.98D_M + 13.214W_M - 611.23$
Madaripur	$R_O = 0.0215R_M - 10.632D_M + 17.87W_M - 570.04$ $R_N = -0.0130R_M + 0.1168D_M + 12.951W_M - 1354.40$
Chandpur	$R_O = -0.0018R_M + 23.338D_M + 21.272W_M - 4770.90$ $R_N = 0.0108R_M + 1.4742D_M + 0.3502W_M - 188.620$
Feni	$R_O = -0.0591R_M + 52.012D_M - 85.232 + 3405.10$ $R_N = 0.0475R_M + 37.144D_M + 1.6024W_M - 4364.20$
Rangpur	$R_O = 0.01217R_M - 1.8401D_M + 4.58W_M - 154.41$ $R_N = 0.0127R_N - 0.1777D_M + 0.3896W_M - 31.05$
Dinajpur	$R_O = 0.0045R_M + 9.9792D_M + 9.791W_M - 2251.20$ $R_N = 0.0107R_M + 0.1904D_M + 1.1555W_M - 151.25$
Bogra	$R_O = -0.0097R_M - 10.991D_M + 21.154W_M - 848.38$ $R_N = 0.0324R_M + 8.0385D_M - 7.9574W_M - 96.58$
Mymensing	$R_O = 0.0765R_M - 1.5392D_M + 14.796W_M - 1325.00$ $R_N = 0.0174R_M - 3.6852D_M + 4.4549W_M - 62.47$
Sylhet	$R_O = 0.0019R_M - 2.3262D_M + 10.771W_M - 644.03$ $R_N = 0.0164R_M - 9.1539D_M + 4.467W_M + 524.02$
Rajshahi	$R_O = -0.0141R_M - 17.329D_M + 5.0232W_M + 1577.70$ $R_N = 0.0137R_M - 1.1279D_M + 2.1784W_M - 105.13$
Ishwardy	$R_O = 0.0371R_M + 29.785D_M + 0.2363W_M - 3348.60$ $R_N = -0.0032R_M - 2.7299D_M + 1.9726W_M + 121.16$
Tangail	$R_O = 0.0369R_M + 1.82D_M - 42.536W_M + 4412.50$ $R_N = 0.0048R_M - 1.9789D_M + 15.963W_M - 1448.70$

CHAPTER IV

Conclusions

Based on the present study, the following conclusions can be drawn:

- The western side of the country is warmer then the eastern side in the monsoon period. The maximum amount of average rainfall is observed in the eastern side of the country and decreases gradually towards west. In the context of the whole monsoon season Jessore and its surrounding get the minimum amount of rain. In the month of October and November, the highest amount of average rainfall is observed in the southern region respectively.
- The CC between November rainfall and average DBT is negative in the northern side and positive in the southern side of the country except Bhola in August and negative in south and northeast side including Ishwardy and positive in central and southeastern region in September. The CC is positive in the south and southeastern side in June and negative in eastern side of the country except Sitakundu in July.
- Post-monsoon rainfall and DBT of monsoon months are positively correlated except Rajshahi-Tangail-Bhola region in June, southern-southeastern side in July, northeastern and Bhola region in August and southern-southwestern side in September all over country.
- October rainfall and WBT of June, July, August and September are negatively correlated in the Tangail region. November rainfall and WBT of monsoon months are positively correlated except northeast-southern region in July and northeast and Bhola region in June and August of the country.
- The post-monsoon rainfall is negatively correlated with the rainfall of July in the northeast, southeast and southern region of the country where as that is positively correlated with the September rainfall in western and eastern side of the country.
- The October rainfall is positively correlated with the rainfall of June in the northwest, west and southern region of the country. But that is negatively correlated with the August rainfall over the maximum region of the country. The November rainfall is positively correlated with the August rainfall in the northern and eastern side and negatively correlated in the southern and southeastern side of the country. That is also positively correlated with the rainfall of September in the northern, southern and western region but negatively correlated in the central and eastern region.
- The DBT and WBT of June, July and August are positively correlated all over the country.

- The CC between October rainfall and WBT & DBT of July is positive in the northwest and central region and negative in the northeast and southern side of the country. The CC between November rainfall and WBT & DBT of August is negative over the northern and positive over the southern side of the country.
- The CC between the rainfall of October, November and post-monsoon and WBT, DBT and rainfall of June, July, August and September are positively correlated all over the country. The CC between DBT, WBT and rainfall of monsoon season and October, November and post-monsoon rainfall are always positively correlated.

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