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Vulnerability to Climate Change: Adaptation Strategies and Layers of Resilience

Climatic Trends in Bangladesh

Uttam K Deb, AKM Nazrul Islam, Muhammad Al Amin, Nafisa Khaled, Ashiqun Nabi, Mazbahul Golam Ahamad, Debi Narayan Rudra Paul, Naveen P Singh and Cynthia Bantilan

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Abstract

This study was conducted as part of the Asian Development Bank (ADB) funded project "Vulnerability to Climate Change: Adaptation Strategies and layers of resilience". Long term climatic datasets were analyzed for Bangladesh and for specific study locations in the country. The report gives general climatic characteristics of the country and trend analysis of important climatic parameters such as temperature, rainfall, etc. Mean annual maximum and minimum temperature showed a rising trend from 1971 to date. During the last decade, there is a reduction in the number of potential rainy days with respect to the 40 year normal in the majority of meteorological stations across the country. However, the annual total rainfall showed an increasing trend in the flood and drought prone areas of the country. The numbers of instances of extreme events, ie, floods, has been high during the last decade.

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Contents

List of Figures

List of Tables

List of Maps

1. Introduction

Global climate is likely to change further and faster over the coming decades resulting in adverse impacts on ecosystems, peoples' livelihoods and economy. There are evidences that climate change has affected global weather patterns, disrupted climatic trends, and resulted in aggravated occurrences of climate related extreme events such as heavy rainfall, droughts, floods, cyclone, storm surges, etc, claiming thousands of lives, destroying billions of dollars' worth of property, and disrupting livelihoods of hundreds of millions of people (DoE 2007). The issue of climate change came to the global forefront following the publication of the first assessment report on climate change by the Intergovernmental Panel on Climate Change (IPCC) in 1990. Later on, IPCC published their second, third and fourth assessment reports presenting scientific evidence of climate change. The nature and extent of these changes vary across different countries, regions, and agro-ecological zones. Experts envisage that such changes are likely to be aggravated with more severe consequences in the coming days. In view of this, the global community has now agreed that now is the best time for formulating mitigation and adaptation measures. However, the best-fit policies should necessarily draw information from rigorous analysis of trends of climatic variables and extreme events.

Bangladesh is globally considered as one of the countries most vulnerable to climate change[1]. The Third Assessment Report of the IPCC (IPCC 2001) also ranked Bangladesh high in the list of most vulnerable countries. According to the Fourth Assessment Report of IPCC (IPCC 2007), several evidences of climate change and its impacts are already visible in Bangladesh: (i) average temperature in May has increased by about 1^{o}C and in November by about 0.5^{o}C during the 14 year period from 1985 to 1998; (ii) annual mean rainfall exhibits increasing trends; whereas the decadal rain anomalies were found to be above long term averages since the 1960s; (iii) serious and recurring floods have taken place during 2002, 2003 and 2004. The number of cyclones originating from the Bay of Bengal have been decreasing since 1970, but the intensity has increased; (iv) the frequency of monsoon depressions and cyclone formation in the Bay of Bengal has increased; (v) salt water from the Bay of Bengal has penetrated 100 km or more inland along tributary channels during the dry season; and (vi) the precipitation decline and droughts have resulted in the drying up of wetlands and severe degradation of ecosystems.

Climate extremes such as drought events characterized by hot days, warm nights, and chronic lack of rain are likely to result in heat-related stress. Increased summer heat directly poses community health risks, especially for women and the elderly. In Bangladesh, hot summer often associates with higher frequency of tornadoes and hailstorms, which make it difficult to manage agricultural production, particularly the Boro crop. Current severity of drought affects almost 2.3 million ha of cropland from April to September and 1.2 million ha in the dry season (October to March). During the monsoon season drought severely affects *T. Aman* rice resulting in a production loss of 1.5 million tons annually (Ramamasy and Baas 2007). It is estimated that under a more aggravated climate change scenario, even more areas would be exposed to severe droughts resulting in more crop loss.

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[1] In various international forums including the 15th meeting of Conference of Parties (COP 15) of United Nations Framework Convention on Climate Change (UNFCCC) held at Copenhagen (2009), Bangladesh was identified to be the country most vulnerable to climate change impacts.

Fresh water resources are already in a declining situation in the drought-prone areas of Bangladesh due to both lack of rain and over-exploitation for irrigation. Ramamasy and Baas (2007) predicted that by 2018, the demand for irrigation may reach 58.6% of the total supply, whereas demand for other sectors is expected to reach 40.7%. The practice of overexploitation of groundwater to meet the growing irrigation requirement may eventually lead to more critical environmental problems such as heavy metal contamination and salinity. Incidence of pests and diseases of crops may increase with longer dry spells and more intense rainfall. Altered temperature and rainfall pattern under a drought regime are likely to shift growth period and susceptibility of pests and vector-borne diseases in both humans and crops. Impact on human health is also a significant issue, while the physical and social disruptions caused by these diseases and extreme events such as droughts may affect the community. High temperature, humidity, and prolonged heat spells are associated with health problems such as dehydration, especially affecting the elderly and children, and water-borne diseases.

On the other hand, floods are the most common water-related natural hazard. Bangladesh is particularly susceptible to flood events primarily because it is a deltaic flood plain with a very low elevation above the mean sea level. The huge inflow of water from upstream catchments along with heavy monsoon rainfall, high density of drainage channels in the country, a low floodplain gradient and congested drainage channels are also responsible for floods in the country (Ahmed and Mirza 2000). Flash floods are exclusively responsible for extensive crop damages in the northeastern haor (tectonic depression) areas. Severe damage to crop and property are also caused by early floods during April and May. According to Ahmed (2006), the extent and depth of rainwater flooding varies within the rainy season and from year to year, depending on the amount and intensity of local rainfall and on the contemporary water levels in the major rivers that control drainage from the land. He also reported that severe floods, which cause extensive damages to crops and some damage to property, especially roads, occur at intervals of about 7-10 years. Catastrophic floods, occurring at intervals of 20-50 years or more, almost totally destroy crops in adjoining floodplains, and also cause considerable damages to houses, roads and other infrastructure. The 1988 and 1998 floods are rated as 50-100 year events.

A number of studies have been attempted to understand the nature and extent of changes in climatic characteristics of Bangladesh. Many of these studies have found clear evidence of change in major climatic parameters such as temperature and rainfall over the last few decades. However, these changes are multifaceted in nature and have different extents and varied magnitudes. It is reported that Bangladesh has been experiencing a significant variation in its annual and seasonal rainfall patterns for the last several years (IPCC 2001, Ahmed 2006). The studies also show that the mean maximum and minimum temperature is also increasing gradually. In the backdrop of current changes, and considering the future vulnerabilities, several attempts were made to forecast the future changes and volatility of major climatic parameters in Bangladesh. The IPCC (2007) has predicted that the average temperature in Bangladesh will increase by another 1.3^{o}C in 2030 and 2.6^{o}C by the year 2070. The report also predicted that by 2030, an additional 14.3% of the landmass in the country will be inundated by floods, while the existing flood-prone areas will be affected in a more severe manner. A one meter rise in the mean sea-level is estimated to inundate about 18% of the landmass, which would affect about 11 percent of the population in the country. Monsoon rainfall is expected to increase by another

11 and 27% by the year 2030 and 2070, respectively. Considering 2030 as the baseline average, Agrawala et al. (2003) forecasted the changes in mean rainfall and temperature in Bangladesh for 2050 and 2100. They predicted that the annual mean temperature will increase from baseline 1.0°C in 2030 to 1.4°C and 2.4°C by the year 2050 and 2100 (Table 1). The deviation of increase would be higher during the months of December, January and February (0.26 by 2050 and 0.46 by 2100) compared to the months of June, July and August (0.23 by 2050 and 0.40 by 2100), which indicates that the fluctuation in temperature might be more visible during the winter than in the monsoon. Similarly, the annual rainfall will increase by 5.6% and 9.7% respectively by the year 2050 and 2100 from the baseline period of 2030. However, they have estimated that the rainfall will decrease by 1.7% and 3.0% during winter. A recent CPD (2009) study found that the average number of rainy days in the 2000s, compared to the period of 1971-2000, decreased in the drought-prone and flood-prone regions, but increased in the tidal surge areas of Bangladesh.

Table 1. GCM projections for changes in temperature and precipitation for Bangladesh.

	Temperature change (°C) mean (standard deviation)			Rainfall change (%) mean (standard deviation)		
Year	Annual	DJF**	JJA	Annual	DJF **	JJA
2030*	1.0 (0.11)	1.1 (0.18)	0.8 (0.16)	3.8 (2.30)	-1.2 (12.56)	4.7 (3.17)
2050	1.4 (0.16)	1.6 (0.26)	1.1 (0.23)	5.6 (3.33)	-1.7 (18.15)	6.8 (4.58)
2100	2.4 (0.28)	2.7 (0.46)	1.9(0.40)	9.7 (5.8)	-3.0 (31.6)	11.8.(7.97)

Note: *Baseline average.
Source: Agrawala et al. (2003).
**DJF represents the months of December, January and February, usually the winter months.
$^{\psi}$JJA represents the months of June, July and August, the monsoon months. GCM refers to general circulation models.

As a consequence of changes in climatic characteristics, many districts of Bangladesh have already encountered severe incidences of droughts and floods, and the situations are assumed to become aggravated in the coming days (Karim et al. 1996; Mirza and Dixit 1997; BCCSAP 2009). Frequent droughts and intense floods are adversely hampering agriculture and other sectors of the country. It is claimed that the agriculture sector is the most vulnerable sector to climate change in Bangladesh, mainly due to incidences of droughts and floods along with sea level rise and impulsive weather patterns. Therefore, it is important for the country to prepare appropriate and effective adaptation strategies to mitigate the negative consequences of climate change on agriculture.

The present study has attempted to analyze the changes in general climate characteristics of Bangladesh. The major objective of the study is to assess long term changes in climatic patterns of Bangladesh through trend analysis of rainfall, and maximum and minimum temperatures. The study also seeks to understand the dynamics of changes in climatic characteristics in the flood-prone and drought-prone areas of Bangladesh especially for the 4 study villages located in these agro-ecological zones. The following chapter presents the methodology of this study. The next chapter deals with an analysis of major changes in climatic characteristics of the country. The fourth chapter analyses and discusses trends of climatic variables for the flood-prone and drought-prone ecological zones with special emphasis on the study villages. And finally, Chapter 5 puts forward the concluding remarks.

2. Methodology

2.1. Data

In order to understand the dynamics of climatic characteristics of Bangladesh, at the national, agro-ecological zones and selected village levels, the study has conducted standard statistical and mapping analysis. For analysis of climatic characteristics, daily data on rainfall, and maximum and minimum temperature for 27 weather stations were collected from the Bangladesh Meteorological Department (BMD) for the period 1971 to 2008. However, due to unavailability of consistent datasets, it was not possible to analyze humidity, sunshine and cloud cover variables. The temperature and rainfall data of a few years were unavailable for some of the stations. In those cases the study used 'climate normal' values as a proxy to avoid inconsistency. Table 2 provides a list of the weather stations in Bangladesh.

Table 2. Locations of Bangladesh Meteorological Department (BMD) Stations.

Station Name	X_COR	Y_COR	LAT	N2	LONG	N4	ALT	EZ
Dinajpur	365790.20	834718.00	25.63	N	88.66	E	37	Drought
Rangpur	426172.90	844822.30	25.72	N	89.26	E	34	Drought
Rajshahi	353944.90	693386.60	24.35	N	88.56	E	20	Drought
Bogra	435303.70	751187.50	24.88	N	89.36	E	20	Drought
Mymensingh	540975.30	737535.80	24.75	N	90.41	E	19	Low Flood
Sylhet	694533.20	752277.90	24.88	N	91.93	E	35	Low Flood
Ishurdi	402483.20	667640.80	24.12	N	89.04	E	14	Low Flood
Dhaka	540098.60	629248.40	23.78	N	90.39	E	9	Low Flood
Comilla	621445.20	596963.40	23.48	N	91.19	E	10	Flood
Jessore	420062.70	562498.80	23.17	N	89.22	E	7	Low Flood
Faridpur	483877.30	610719.30	23.61	N	89.84	E	9	Flood
Madaripur	518762.70	561770.30	23.17	N	90.18	E	5	Flood
Khulna	456632.40	521635.70	22.80	N	89.58	E	4	Tidal Surge
Barisal	536809.80	510151.90	22.70	N	90.36	E	4	Tidal Surge
Bhola	567637.60	510271.80	22.70	N	90.66	E	5	Tidal Surge
Feni	640285.90	544954.50	23.01	N	91.37	E	8	Flood
Maijdee Court	610851.80	524433.60	22.83	N	91.08	E	6	Tidal Surge
Hatiya	616159.20	465295.10	22.29	N	91.13	E	4	Tidal Surge

Continued

Table 2. Locations of Bangladesh Meteorological Department (BMD) Stations *continued.*								
Station Name	X_COR	Y_COR	LAT	N2	LONG	N4	ALT	EZ
Sitakunda	668856.20	504500.30	22.64	N	91.64	E	4	Tidal Surge
Sandwip	650012.10	488627.90	22.50	N	91.46	E	6	Tidal Surge
Chittagong	684570.90	471415.00	22.34	N	91.79	E	6	Non-Flood
Kutubdia	690250.30	414997.40	21.83	N	91.84	E	6	Tidal Surge
Cox's Bazar	705183.00	374324.60	21.46	N	91.98	E	4	Tidal Surge
Teknaf	734765.40	308914.10	20.87	N	92.26	E	4	Tidal Surge
Rangamati	725903.30	508021.90	22.67	N	92.20	E	63	Non-Flood
Patuakhali	534986.10	472575.70	22.36	N	90.34	E	3	Tidal Surge
Khepupara	522893.10	430006.80	21.98	N	90.22	E	3	Tidal Surge

Source: Bangladesh Meteorological Department (BMD)

2.2. Agro-Ecological Zones

The present study has adopted the agro-ecological zones suggested by Deb (2005), which have classified Bangladesh into various agro-ecological zones (AEZs) based on favorable geographical locations considering drought, flood and tidal surge maps prepared by Bangladesh Agricultural Research Council (BARC). It has classified 21 districts (old districts or regions) into six zones – drought prone, flood prone, low flood prone, not flood prone, tidal surge and mixed zone (Table 3 and Map 1)[2].

Table 3. Distribution of districts to different ecological zones.	
Ecological zones	Regions
Not Flood prone	Chittagong HT, Dhaka
Low flood prone	Jamalpur
Flood prone	Sylhet, Tangail, Jessore, Kushtia, Pabna, Rangpur
Drought prone	Rajshahi, Dinajpur, Bogra, Faridpur
Tidal surge	Noakhali, Barisal, Khulna, Patuakhali
Mixed	Mymensingh, Comilla, Kishoregonj (Flood prone and not flood prone) and Chittagong (not flood prone, flood prone, tidal surge)

Source: Deb (2005)

[2] It was done in four phases: First, flood prone zones were identified. Districts with more than 50% area as "high flood prone area" were identified as high flood prone zones, while districts with more than 50% area as "low flood prone area" were identified as low flood prone zones. On the other hand, districts with more than 50% area as flood free area were identified as flood free zones. Second, drought prone zones were identified. Districts with more than 50% area as "drought prone area" were identified as drought prone zones. Third, tidal surge zones were identified. Coastal districts, which are experiencing severe flood due to tidal surge were identified as tidal surge zones. Fourth, mixed zones were identified. Two districts contained mixed patterns and did not fit the characteristics of any one zone, so these were classified as mixed zone.

Map 1: Major Agro-Ecological Zones of Bangladesh.
Source: Deb 2005.

2.3. Selection of Study Areas for Farm Level Analysis

The present study on farmers' perceptions of climate changes, assessing their vulnerability and measures of adaptation was conducted at four selected villages located in four districts, representing two major AEZs of the country – the drought-prone zone included *Khudiakhali* village of Chuadanga district and *Baikunthapur* village of Thakurgaon district, while the flood-prone zone included *Nishaiganj* village of Mymensingh district and *Paschim Bahadurpur* village of Madaripur district. Selection of the survey villages has also considered the socio-economic characteristics (eg, connectivity, infrastructure and access to market) of the respective villages. From the chosen villages, Nishaiganj and Khudiakhali have good socio-economic infrastructure and better connectivity; on the contrary, Paschim Bahadurpur and Baikunthapur are in relatively weaker conditions in terms of socio-economic resources and connectivity to markets.

2.4. Analysis of Climatic Variables

The software "*Weather Cock*", developed by the All India Coordinated Research Project on Agro-meteorology, Central Research Institute for Dryland Agriculture, India was used for analyzing climatic data. Daily data of rainfall, and maximum and minimum temperatures were fed to the software for analyzing monthly, seasonal, and annual trends. For graphical representation, GIS software "Arc View" was used to prepare maps.

In order to analyze the dispersion of the values of various climatic variables in a certain season or time period from normal mean, the study has calculated standard deviation (SD) of the respective climatic parameters using the following formula:

$$\sigma = \sqrt{\sum (x-\mu)^2 / (n-1)}$$

where,

σ = standard deviation

x= respective variable

μ = sample mean

n= sample size

In addition, the coefficient of variation (CV) was calculated to estimate dispersion of the meteorological data with reference to mean and standard deviation using the following formula:

$$CV = \frac{\sigma}{\mu} \times 100$$

where,

CV= Coefficient of Variation

σ = Standard deviation

μ = Mean

The values of SD and CV were used throughout the report to measure and compare the seasonal and annual fluctuations of major climatic areas. It needs to be mentioned here that the study, which attempted to analyze the major changes in general climatic characteristics of Bangladesh, has some limitations. Due to data deficiency the study was unable to analyze some of the important climatic variables such as humidity, sunshine, cloud cover and wind speed. Moreover, from the available six agro-ecological zones, the study has selected villages from only two zones (drought-prone and flood-prone). The inclusion of villages from all of the zones, particularly from tidal surge zone, would have provided better results of the study.

3. General Climatic Characteristics of Bangladesh

3.1. Geomorphic Contexts of Bangladesh

Bangladesh lies in the northeastern part of South Asia between 20°34′ and 26°38′ North latitude and 88°01′ and 92°41′ East longitude. The country occupies an area of 147,570 sq. km (BBS 2010). Geologically, Bangladesh is a part of the Bengal Basin, which has been filled by sediments washed down from the highlands on three sides of it, especially from the Himalayas. The country consists of low and flat land[3], formed mainly by the sediments carried by the Ganges, the Brahmaputra and the Meghna River systems, except for the hilly regions in the northeastern and southeastern parts. The country has about 24,000 km of rivers, streams and canals that together cover about 7% of the country's surface. The alluvial soil is thus continuously being enriched by heavy silt deposited by rivers during the rainy season (BBS 2010).

3.2. Major Climatic Seasons in Bangladesh

The country enjoys a humid, warm and tropical climate (Ahmed 2006). The overall climate of Bangladesh is primarily influenced by monsoon and partly by pre-monsoon and post-monsoon circulations. The southwest monsoon originates over the Indian Ocean, and carries warm, moist and unstable air. Besides the monsoon, the easterly trade winds are also active, providing warm and relatively drier circulation (Ahmed 2006).

Bangladesh has four clearly demarcated climatic seasons. These are: (i) winter (December to February); (ii) pre-monsoon (March to May); (iii) monsoon (June to early-October); and (iv) post-monsoon (late-October to November) (Ahmed 2006, Agrawala et al. 2003). The general characteristics of the seasons are as follows:

- ***Winter*** (December to February), a relatively cool and dry season, which begins in December and ends in February. During these months the temperature ranges between minimum 7°C-13°C and maximum 24°C-31°C (BBS 2010). Although the minimum sometimes falls below 5°C in most northern parts of the country, frost is rare. January is the coldest month in Bangladesh (Ahmed 2006, Agrawala et al. 2003).
- ***Pre-monsoon*** (March to May), a comparatively hot season, begins in March and ends in May. During these months the average maximum temperature ranges from 35°C to 37°C, whereas the average minimum temperature remains between 16°C to 27°C (BMD 2010). This season experiences a very high rate of evaporation, occurrence of thunderstorms and erratic but occasional heavy rainfall (Ahmed 2006, Agrawala et al. 2003). In the pre-monsoon season, the mean temperature gradient is oriented from southwest to northeast (warmer to cooler zone). Kalbaishakhi storms, from the West and northwest parts of the country, sometimes become very damaging for crops and fruits during this time period.
- ***Monsoon*** (June to early-October) brings both fortunes and sufferings for the country. A normal monsoon is very effective for crops, whereas excess-rainfall brings serious floods in the country and causes widespread damage to crops and property. This season is highly influenced by the influx of moisture from the Bay of Bengal. About four-fifths of the mean annual rainfall (80%) occurs during the monsoon period. The mean monsoon temperatures

[3] About 80% of the land is floodplains with very low mean elevation above the sea level.

are higher in the western districts as compared to the eastern districts (Ahmed 2006, Agrawala et al. 2003).

- ***Post-monsoon*** (late-October to November) is characterized by less rainfall and a gradual decrease in minimum temperature, especially during the night. The annual average monsoon rainfall generally ranges from 1200 mm in the far-west to over 5000 mm in the eastern and northeastern districts of Bangladesh. The average rainfall in the country is about 2300 mm (Ahmed 2006, Agrawala et al. 2003).

3.3. Analysis of Rainfall in Bangladesh

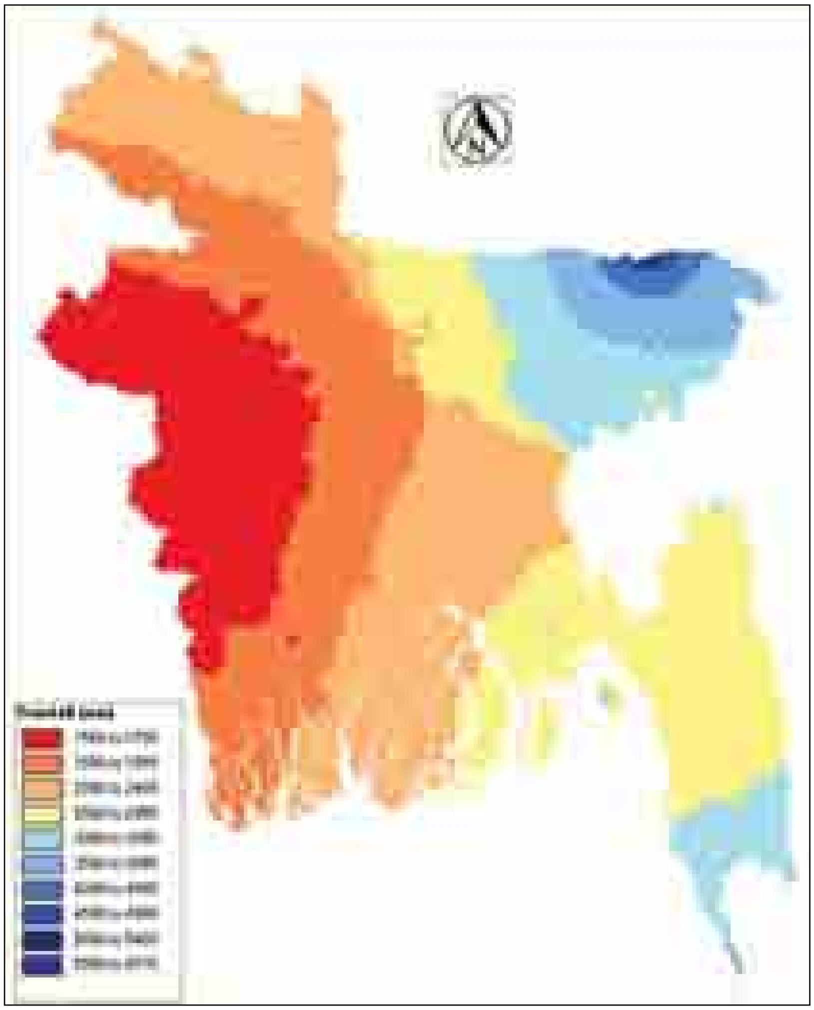
Bangladesh receives intensive rainfall both in terms of magnitude and frequency in the monsoon period due to its unique geo-climatic position in the tropical region. Winter is comparatively drier, and accounts for only 2% of the total annual rainfall in the western districts to 4% in the eastern areas of the country. During the pre-monsoon season the amount of rainfall varies from 10 to 25% of the annual total. Rainfall during the monsoon period is mainly caused by the tropical depressions in the Bay of Bengal, which varies from 1000 mm in the western part to almost 2000 mm in the South and northeastern areas of the country.

Annual Rainfall Distribution

The analysis of long term annual rainfall distribution over Bangladesh reveals that different parts of the country have experienced diverse rainfall patterns throughout the last few decades (BMD 2010). The spatial analysis of rainfall indicates that the West and west-central parts of the country recorded the lowest amount of rainfall ranging from 1564 to 1799 mm over the 1971-2008 period. Conversely, the northeastern and southeastern parts of the country experienced maximum annual rainfall of about 3000 to 5775 mm (Map 2) over the same period. The central parts of the country experienced moderate rainfall of 1800 to 2999 mm in the last few decades.

The zone-wise analysis of rainfall reveals that the trend and patterns of rainfall over the last forty years have changed significantly in Bangladesh. During this period, the drought-prone zones of the country experienced diverse rainfall patterns. The annual rainfall decreased in Rajshahi and Rangpur regions, while it increased variably in the Dinajpur region of Bangladesh. However, the Bogra station did not observe any striking change over the period, but rather followed a steady trend. Taking variation of annual rainfall into account, Dinajpur region displays the highest variability. Meanwhile, other stations in the drought-prone areas showed downward trends in variability during the period 1985-1990. Among the non-flood prone zones of Bangladesh, annual rainfall decreased in Rangamati, but increased in Chittagong. In the low flood-prone areas, except for Sylhet and Ishwardi, the amounts of annual rainfall have increased significantly. Among the regions of low flood-prone areas, Dhaka, Jessore and Mymensingh have received remarkably higher amounts of annual rainfall in the recent years.

In terms of variability in rainfall, Dhaka, Jessore and Mymensingh regions, which experienced lower deviations in the annual rainfall during the 1980s and 1990s, are now facing higher fluctuations. Overall, annual rainfall decreased in the flood-prone areas. On the other hand, Comilla region showed a slightly upward trend since 2000. This clearly indicates a changing pattern in rainfall in the country, mostly in the recent years.



Map 2. Long term mean annual rainfall distribution in Bangladesh.

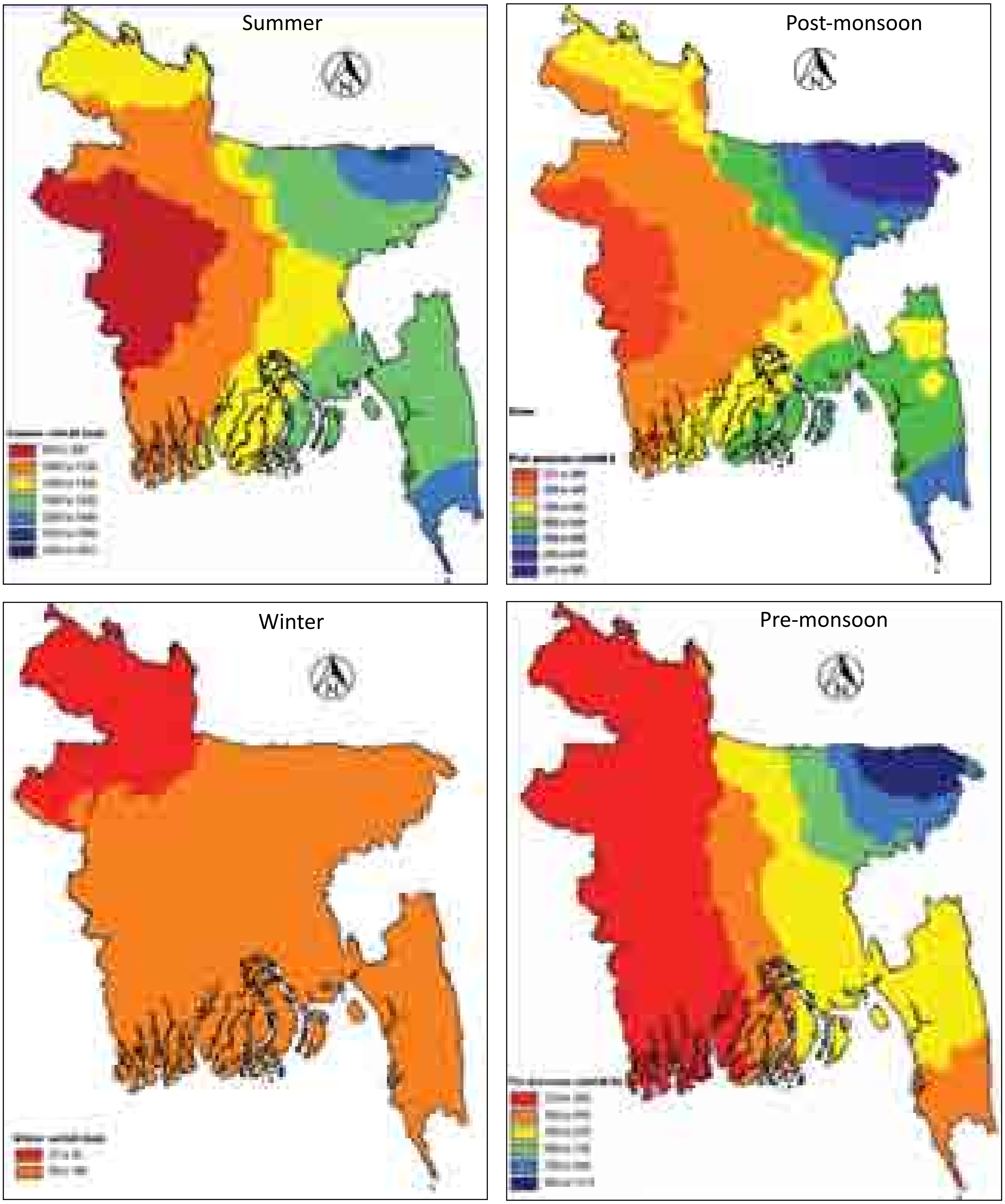
Source: BMD 2010.

Seasonal Rainfall

Map 3 depicts the seasonal rainfall pattern over the country. In general, it can be inferred from the figure that spatial distribution pattern of rainfall is similar throughout the seasons, though the amount varies significantly.

Summer	Post-monsoon
Winter	Pre-monsoon

During the pre-monsoon period, the eastern parts of the country receive ample rainfall; the western regions remain mostly rainless, receiving merely 400 mm or less rainfall. The northeastern regions of Bangladesh receive the highest rainfall, over 850 mm during the pre-



Map 3. Long term seasonal rainfall distribution in Bangladesh.
Source: BMD 2010.

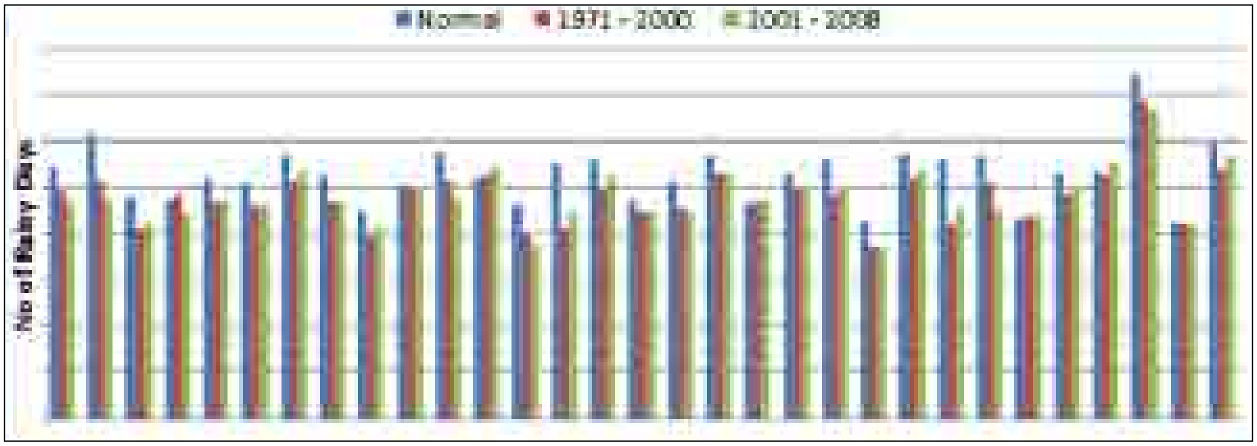


Figure 1. Number of annual rainy days.
Source: Compiled from BMD 2010.

monsoon time, whereas the mid-regions of the country receive between 450 to 1000 mm of rainfall. With the onset of the southwestern monsoon in the month of June, heavy rainfall is observed almost all over the country.

The northeastern and southeastern regions receive the highest amount of rainfall (more than 2000 mm) and the mid-western districts receive the lowest rainfall (800 to 1000 mm) during the monsoon period in the country. Almost similar patterns of rainfall distribution prevail in the post-monsoon season, though this amount of rainfall is lower than rainfall in the southwest monsoon season. However, during the three winter months (December to February), the driest months in Bangladesh, the country receives very scanty amounts of rainfall.

Analysis of rainy days

The study attempts to analyze the data on the number of annual rainy days for 27 meteorological stations in Bangladesh. It is observed that the normal annual number of rainy days ranges from 85 (Tangail) to 149 (Sylhet) across the station areas (Table 3). It is observed that the number of annual rainy days is more than 100 for 67% of the stations, while it is less than 90 days in four stations (Dinajpur, Rajshahi, Satkhira and Tangail).

Figure 1 above presents the changes in the number of rainy days across the stations with a comparison between the periods of 1971-2000 and 2001-2008. The number of average rainy days varies from 60 in the western regions to 95 in the southeastern to over 100 days in the northeastern parts of the country during the 2001-2008 period, whereas it was 99, 121 and 132 for these regions during the 1971-2000 period. Maximum amount of rainfall was recorded in Sylhet, Sunamganj, Cox's Bazar and Bandarban districts during 1971-2000, and the same was observed in the districts of Teknaf, Sylhet, Hatiya and Cox's Bazar during the 2001-2008 period.

Table 4 presents the number of annual rainy days for the 27 meteorological stations of Bangladesh with a comparison of two time periods, 1971-2000 and 2001-2008. It shows the changes in rainy days between two comparable periods in different meteorological stations across the country:

Table 4. Number of annual rainy days.

Station	Normal	Average 1971 - 2000	Average 2001 - 2008
Barisal	109	99	94
Bhola	123	103	95
Bagura	96	82	85
Chandpur	95	97	88
Chittagong	104	94	95
Comilla	102	92	92
Cox's Bazar	113	103	107
Dhaka	105	94	94
Dinajpur	89	78	83
Faridpur	101	100	98
Feni	115	103	95
Hatiya	104	105	108
Ishwardi	93	81	75
Jessore	110	82	88
Khepupara	112	99	105
Khulna	95	89	90
Madaripur	103	91	89
Maijdee Court	113	106	106
Mongla	93	94	95
Mymensingh	106	100	98
Patuakhali	112	97	101
Rajshahi	86	74	74
Rangamati	114	104	107
Rangpur	112	84	90
Sandwip	113	102	90
Satkhira	87	87	87
Sitakunda	106	97	99
Srimangal	107	105	112
Sylhet	149	138	133
Tangail	85	85	84
Teknaf	120	108	113

Source: Compiled from BMD 2010

3.4. Analysis of Temperature

Both minimum and maximum temperatures in Bangladesh showed a steady increasing trend since 1971. A comparison of the monthly average temperature between the periods of 1971-2000 and 2001-2008 clearly reflects that the mean monthly temperature is on an increasing trend after 2000. The same trend is also revealed by the analysis of the CVs of monthly minimum and maximum temperature.

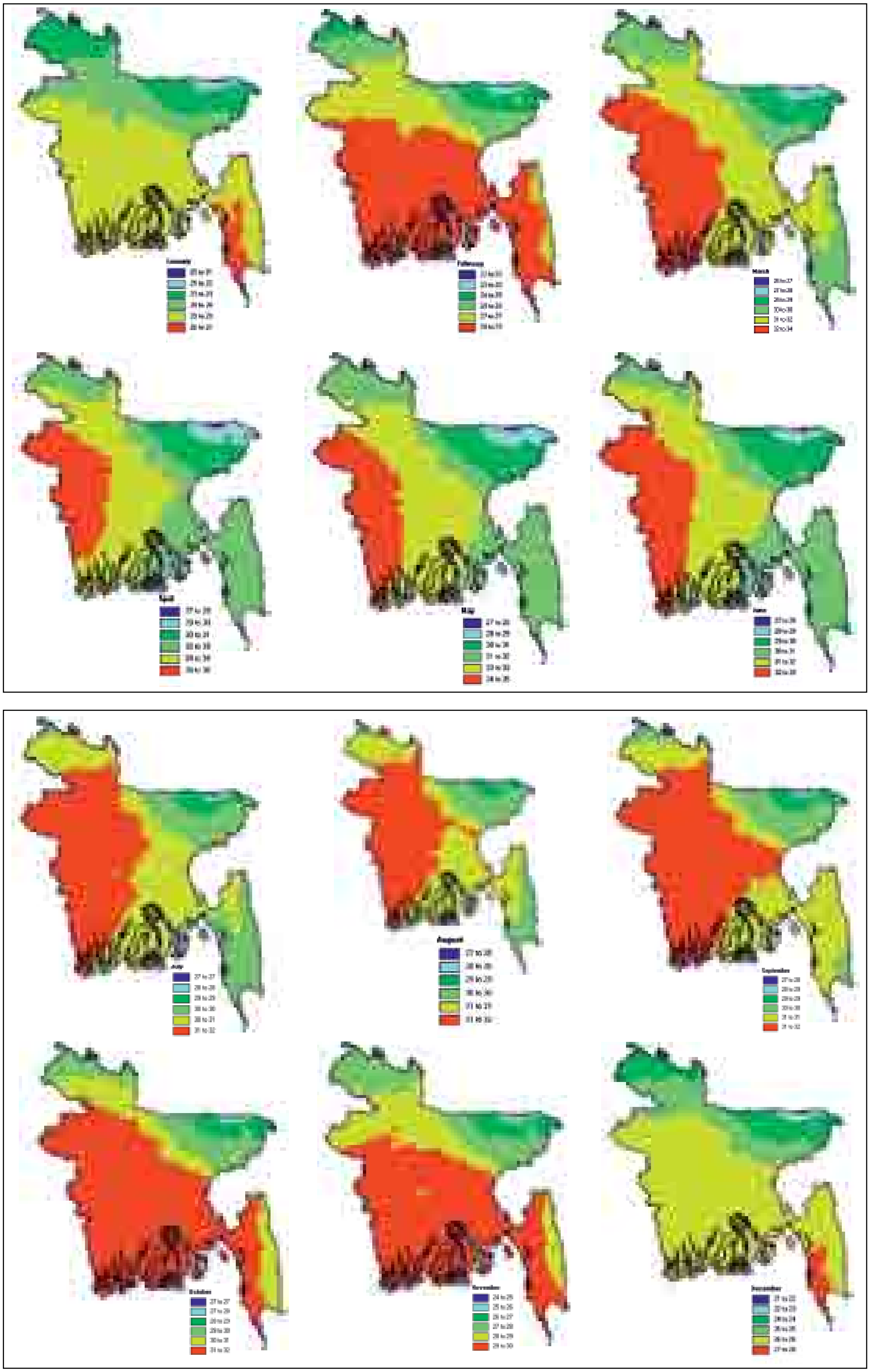
Maximum Temperature

The spatial distribution of the average monthly maximum temperature of Bangladesh is presented in Map 4. During the winter (November, December, January and February), a general trend of North to South ascending temperature gradient is observed. Considering December and January as the representative months of this season, the distribution of maximum temperature reveals that it increased from 24°C in the northern part to 26°C in the southern part over the period 1971-2008. However, most of the central to southern areas of the country experienced a temperature of 28°C to 30°C during the pre-and post-winter months (November and February).

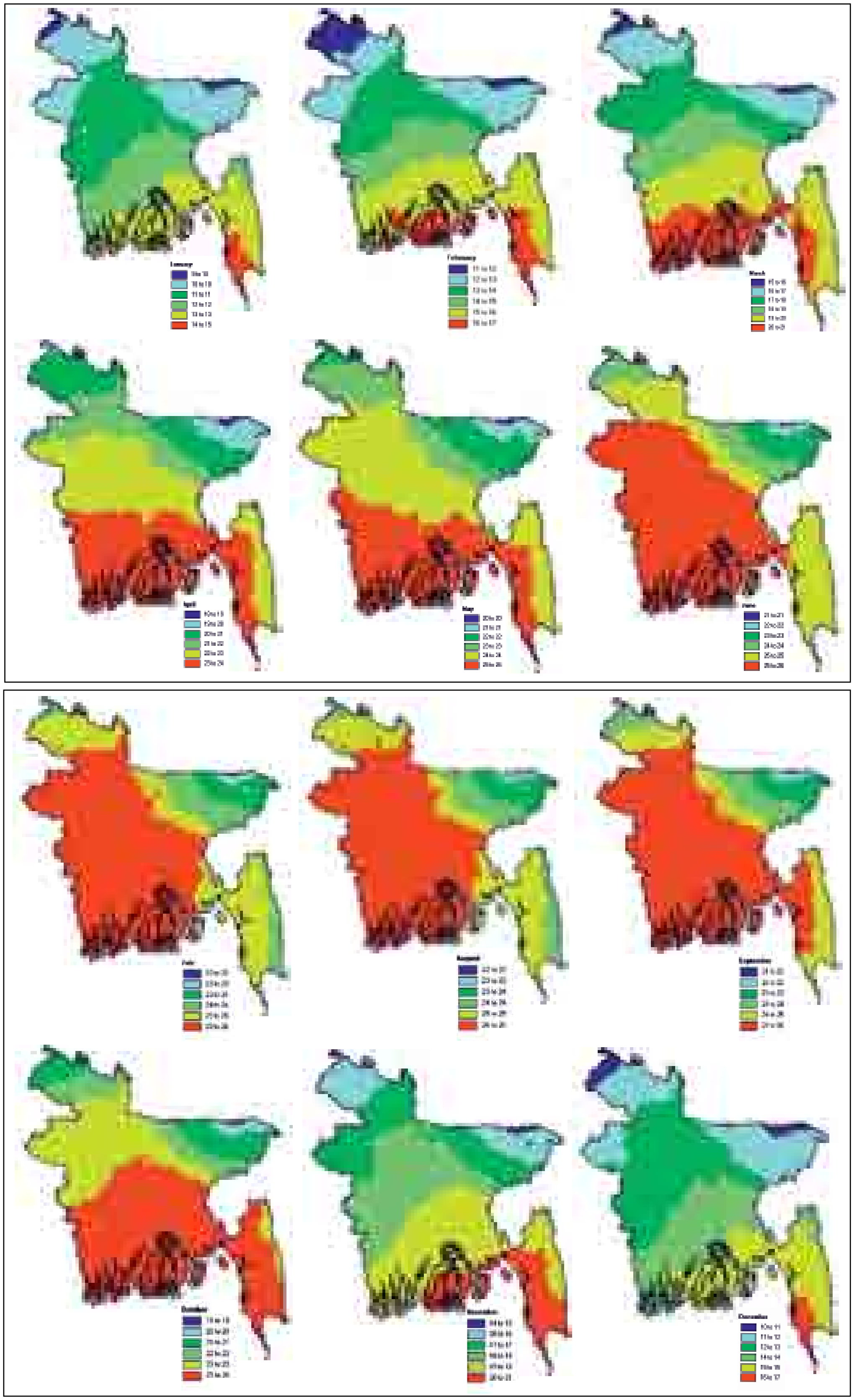
The pre-monsoon season displays a northeast to west temperature gradient from 27 to 36°C. A more or less similar pattern is also observed throughout the country, except for the western parts, which experiences 31 to 32°C in the same period. The post-monsoon period experiences similar temperature conditions over most of the western and southern parts of Bangladesh (Map 5).

Maximum temperature increased insignificantly in the period between 2001 and 2008 compared to that of 1971 to 2000 in the drought-prone areas of the country (Comilla, Faridpur, Maijdicourt and Madaripur), except for the winter season, when these areas observed a minor fall in maximum temperature. April was found to be the hottest and January the coldest month throughout the period of 1971-2008. The highest maximum temperature decreased from 34.2°C for the period 1971-2000 to 33.7°C in 2001-2008, while the lowest maximum temperature was 24.5°C during 1971-2000 and decreased marginally to 24.2°C in 2001-2008. The coefficient of variations increased significantly over the 2000s compared to the previous three decades. This indicates that the variation in maximum temperature is increasing gradually in drought-prone regions of Bangladesh.

Flood-prone and low flood-prone areas of the country (Mymensingh, Sylhet, Dhaka, Jessore, Chittagong and Rangamati) recorded some mixed changes during the two comparative periods. Maximum temperature increased in Rangamati and Sylhet areas, while it decreased in Mymensingh area. Chittagong experienced some increase in maximum temperature during winter while in Dhaka it decreased over the same period. The CV of maximum temperature for Chittagong area increased during the 2001-2008 period, while it decreased in Rajshahi, except for the winter season. The CV also increased for maximum temperature for Dhaka and Mymensingh, except for the periods of pre-monsoon and winter seasons.



Map 4. Monthly long term normal maximum temperature.
Source: BMD 2010.



Map 5. Monthly long term normal minimum temperature.

Source: BMD 2010.

The maximum temperature was more or less stagnant throughout the last 40 years in non-flood prone areas of the country (Barisal, Cox's Bazar and Khulna). The coefficient of variation also indicates little variation in maximum temperature in these regions. The highest maximum temperature during 1971-2000 was 34.6°C, while it recorded 34.4°C over the corresponding period of 2001-2008. Conversely, the lowest maximum temperature was 25.6°C during 1971-2000, which decreased very slightly to 25.2°C during the period of 2001-2008.

Minimum Temperature

Distribution of long term normal minimum temperature over the country shows a spatial pattern of the lowest temperature in the northwest to the highest temperature in the southeast in the winter season. However, pockets of lower temperature similar to the northwestern part (9 to 11°C) can be observed in the extreme southeastern part of the country (Map 5).

In the pre-monsoon season of March to May, North to South ascending gradient of minimum temperature pattern prevails all over the country. The lower minimum temperature remains between 15 to 20°C, whereas approximately 25°C of minimum temperature prevails over the southern part of the country.

During the monsoon and post-monsoon seasons, most parts of the country, from central to the southern edge, experience 25°C to 29°C of minimum temperature, with the lowest of about 19°C in the northeastern region.

In the pre-monsoon season of March to May, North to South ascending minimum temperature gradient prevails over the country, which remains between 15 to 20°C. On the other hand, minimum temperature of about 25°C prevails over the southern parts of the country in this season. During the monsoon and post-monsoon seasons, for the most part, the country experiences minimum temperatures of 25-29°C, with the lowest limit of nearly 19°C in the northeastern regions of the country.

The monthly minimum temperature increased significantly in the drought-prone areas of Bangladesh during the period 2001-2008 compared to 1971-2000. The variability in the monthly minimum temperature increased quite sharply during the comparable periods. The most significant variability was observed during the winter season after the year 2000, which indicates some unstable fluctuations of minimum temperature.

The flood-prone, low flood-prone and non-flood prone areas also experienced a significant rise in the minimum temperature during the 2001-2008 period. Similarly, the variability in the minimum temperature also increased irrespective of season. The lowest minimum temperature for the period 1971-2000 was 11.2°C, which rose to 12.5°C during the period 2001-2008.

3.5. Analysis of Cloud Cover and Humidity Distribution

Clouds

The cloud cover in Bangladesh has two opposing seasonal patterns and coincides with the winter monsoon coming from the northeastern parts of India and the southwest monsoon coming from the Bay of Bengal. Due to the influx of cold and dry winds from the Himalayan ranges during winter, the cloud cover comes down to its minimum, only about 10% almost all over the country; but with the progression of the season, it increases and reaches about 50-60% by the end of the pre-monsoon period (Banglapedia 2010). It then reaches its highest level during the monsoon period. In the middle of the rainy season (July and August) the cloud cover reaches 75-90%, more extensive in the southern and eastern parts of Bangladesh (90%) than in the northwestern parts (75%) (Banglapedia 2010). On the other hand, during the post-monsoon season the cloud cover starts decreasing rapidly, dropping to 25% in the northern and western parts and to 40-50% in the southern and eastern parts of the country (Banglapedia 2010).

Humidity

Bangladesh, being in a sub-tropical and monsoon-driven climatic region, is characterized by high humidity. March and April are the least humid months in most of the northwestern parts of the country. The lowest average relative humidity (almost 57%) is recorded in Dinajpur in the month of March during the study period. In contrast, the least humid months in the northeastern parts are from January to March. The lowest monthly average humidity has been recorded at Brahmanbaria in the month of March (58.5%). The relative humidity persists at over 80% throughout the country during the period of June to September (monsoon season). The average relative humidity for the whole year generally ranges from 78.1% at Cox's Bazar to 70.5% at Pabna (Banglapedia 2010).

4. Climatic Characteristics of Major Agro-Ecological Zones of Bangladesh (Flood and Drought-Prone Areas)

The present study has adopted Deb's (2005) classification for analyzing climatic characteristics of various agro-ecological zones (AEZs) of Bangladesh. Four selected villages, Nishaiganj (Mymensingh) and Paschim Bahadurpur (Madaripur) from flood-prone zones, and Khudiakhali (Kushtia/Rajshahi) and Biokunthapur (Thakurgaon) from drought-prone zones, are selected for the present study, of which Mymensingh is a low flood-prone zone while Kushtia (Rajshahi) is considered as a low drought-prone zone.

4.1 Climatic Patterns in the Flood-prone Zones of Bangladesh

Bangladesh has 230 rivers with a vast flood-plain comprising of very low lands. About two-thirds of the country is only above five meters from the mean sea-level (CEGIS 2006). IPCC (2007) predicts that an increase in the monsoon rainfall across southeast Asia and the melting Himalayan glaciers will result in increased water volumes in rivers that flow into Bangladesh from India, Nepal, Bhutan and China. Bangladesh is the sixth most vulnerable country to floods in the world (UNDP 2004). In an average hydrological year, about a quarter of the country is flooded (Hofer 1998), though catastrophic floods affect about two-thirds of the country (Ahmad et al. 2000). Four main types of natural floods usually occur in Bangladesh – flash floods, river floods, rainwater floods and coastal floods induced by storm surges (Ahmad et al. 1994; Ahmad et al. 2000). The rainfall variability within the country and in the Ganges-Brahmaputra-Meghna (GBM) catchment areas often determines the intensity, timing and location of flooding in Bangladesh.

Areas affected by various types of floods shown in Map 6 indicate that the central, central-west and central-eastern parts of the country are the most vulnerable to floods in Bangladesh. The flood water generally inundates over 50 cm above the danger level in these areas at the time of floods. Conversely, the North, southwest and southeastern parts of the country are considered as low-flood prone or flood free areas. The incidence of flash-floods occurs mostly in the hilly northeastern and southeastern regions such as Panchagarh, Sunamganj, Habiganj, Netrokona, Sherpur and Sylhet during the months of April and May.

Map 6. Flood-prone areas of Bangladesh.
Source: BWDB 2010.

The analysis literature such as IPCC (2001), CPD (2009), Ahmed (2006), among others have found that incidences of flood over the last three decades in Bangladesh have changed its manifestation with a lesser frequency but increased severity (Figure 4.3). Severe floods affecting at least 38% of the total landmass of the country, were observed in 1987, 1988, 1998, 2004 and 2007. Among them, the floods of 1988 and 1998, which inundated 61% and 68% of the total landmass area, respectively, were most severe both in terms of intensity and damage. On the other hand, the intensity of flash-floods is increasing over time in the haor areas of Bangladesh, although the frequency has decreased marginally in recent years.

Floods have significant impacts, particularly on agriculture and the livelihood activities of the poor and the rural people of Bangladesh. Sudden flash-floods damage paddy and other winter crops. Even in 2010, at least 50,000 hectares of paddy crops of the haor belt of Bangladesh (Sunamganj, Netrokona, Habiganj and Sylhet) were damaged due to flash floods (DAE 2010). The river and rainwater floods damage agricultural produce, mainly Aman and Boro paddy and vegetables throughout the lower regions of the country. Tidal and storm-induced floods in the coastal districts also damage crops, reduce soil fertility due to increased soil-salinity and destroy property and lives of the coastal people. During the recent flood with the super cyclone SIDR in 2007, approximately 1.2 million acres of crops were destroyed (GoB 2009). The *Aila* cyclone in 2009 destroyed about 27,400 households at Dacope, 42,440 in Koyra and 66,850 at Shyamnagar. It damaged about 0.2 million acres of productive cropland and aggravated the overall food insecurity situation of the area (Kumar et al. 2010). Besides stormy weather, the brine flooding caused the maximum damage in the affected coastal belts.

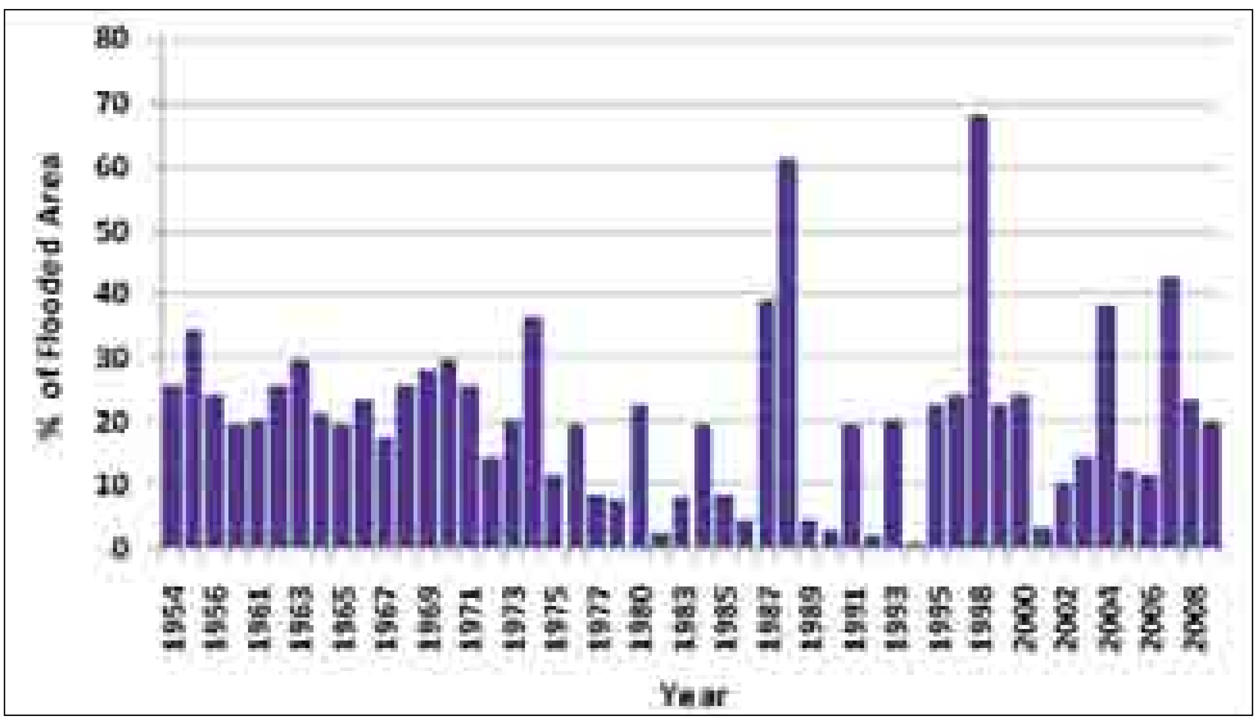
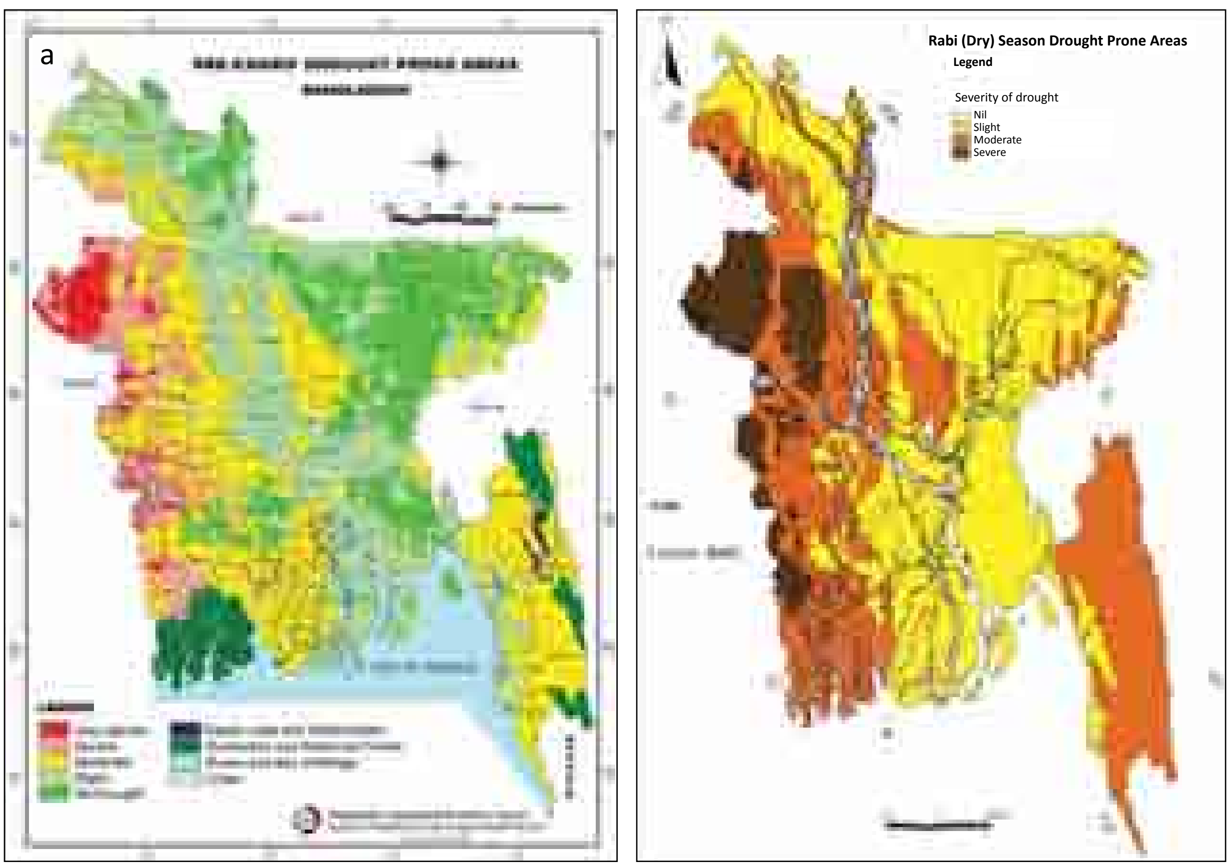


Figure 2. Percentage of flood affected areas in Bangladesh since 1954.
Source: BWDB 2009.

In the backdrop of global climate change and its possible impacts on Bangladesh, it is important to figure out the nature, pattern and intensity of future floods in Bangladesh. Alam et al. (1998) attempted to examine the flood susceptibility of Bangladesh under various climate change scenarios and predicted that about 18% of current low flooded areas would be vulnerable to higher levels of flooding, while about 12 to 16% new areas would be at the risk of varied degrees of inundation by the year 2030. They also predicted that in an average hydrological year, flood prone areas are expected to increase from about 25% to 39% by 2030. Increased severity and uncertainty of flood incidences in the coming years will be a serious threat to the agriculture and food security issues for Bangladesh. Given the incidences of global food grain price hikes in the recent years (late 2007, 2008, 2010 and early 2011), it is extremely important for Bangladesh to take into consideration the climate-led natural disruptions on the economy in the coming years.

4.2 Climatic Patterns in the Drought-prone Areas of Bangladesh

Two critical drought seasons prevail in Bangladesh. These are: *kharif*-drought and *rabi* and pre-*kharif* drought. Bangladesh experiences *kharif* drought normally during the months of June/July to October, whereas *rabi* and pre-*kharif* drought occurs during the months of January to May. Shortage of rainfall is the main cause of drought during the *kharif* season, while *rabi* and pre-*kharif* drought is caused due to the cumulative effect of parched days, higher temperatures and low soil moisture content.



Map 7. Season-wise drought-prone areas in Bangladesh.

Source: BRAC 2010.

Map 7 (a) presents the pre-*kharif* drought-prone areas in Bangladesh, classified into five categories - very severe, severe, moderate, slight and no drought regions. It can be seen that Rajshahi, Nawabgan and Bogra fall under the category of very severely drought affected areas. Conversely, Sunamganj, Habiganj, Netrokona, Sherpur and Sylhet fall under drought free zones. From the figure it is also clear that Chuadanga and Naogaon are the severe drought-prone areas, whereas the northwest and some parts of the southwest zones of the country are moderately drought affected zones. The western regions of the country have the tendency to become drought-prone, whereas drought-free regions mostly fall in the eastern parts of the country. Most of the central Brahmaputra belts have fewer drought incidences and the hill tract regions are moderately drought-prone.

Similarly, *rabi* season drought-prone areas are presented in Map 7 (b), which categorizes the country into four regions according to the severity of drought - nil, slight, moderate and severely drought affected regions. Map 7 (b) shows that Naogaon, Rajshahi, Nawabganj, Bogra and Natore regions are usually affected with severe droughts during the *rabi* season, whereas the south and southeastern districts such as Chittagong, Cox's Bazar, Rangamati, Bandarban and Khagrachari are known to be moderately drought-prone zones in the country. In addition, most of the western regions are vulnerable to moderate droughts in the *rabi* season. The central-south, northeastern and central-eastern districts of the country are recognized as slightly drought-prone areas. Lack of timely rainfall and water scarcity in many rivers during the dry season are the major reasons for drought in Bangladesh. The analysis of annual rainfall data from 1954 to 2008 reveals that the quantity of rainfall is increasing day by day in Bangladesh, but the variability in the annual rainfall has slightly decreased with some clear seasonal variation over the same time period. The trend line in Figure 4.5 shows a clear upward tendency of rainfall in Bangladesh throughout the last six decades. The CV of annual rainfall (in mm) has decreased from 12 in 1954-1970 to 11 in 1971-2008, which indicates that the variability in annual rainfall is decreasing gradually in Bangladesh since 1971.

The amount of rainfall has also been increasing in the *kharif* season (July to October). The trend line of the *kharif* season rainfall presented in Figure 4.6 shows a slow upward pattern; however the variability in the amount of rainfall has increased significantly in the recent decades. The CV for *kharif* season rainfall over the 1954-1970 period was 14, which increased to 18 during 1971-2008, indicating an irregularity in the rainfall pattern in the later period. This irregularity has increased the occurrence of drought in the last four decades in the *kharif* season.

The intensity of drought has also increased in *rabi* and pre-*kharif* season (January to May). The analysis of rainfall data for 54 years (from 1954 to 2008) shows that the variability of rainfall has increased since 1971, although the absolute amount of rainfall increased over the same period (Figure 4.6). The CV in rainfall has increased from 22 during 1954-1970 to 27 in 1971-2008. This instability in the occurrence of rainfall implies a greater occurrence of drought in the *rabi* and *kharif* seasons in Bangladesh in the recent decades.

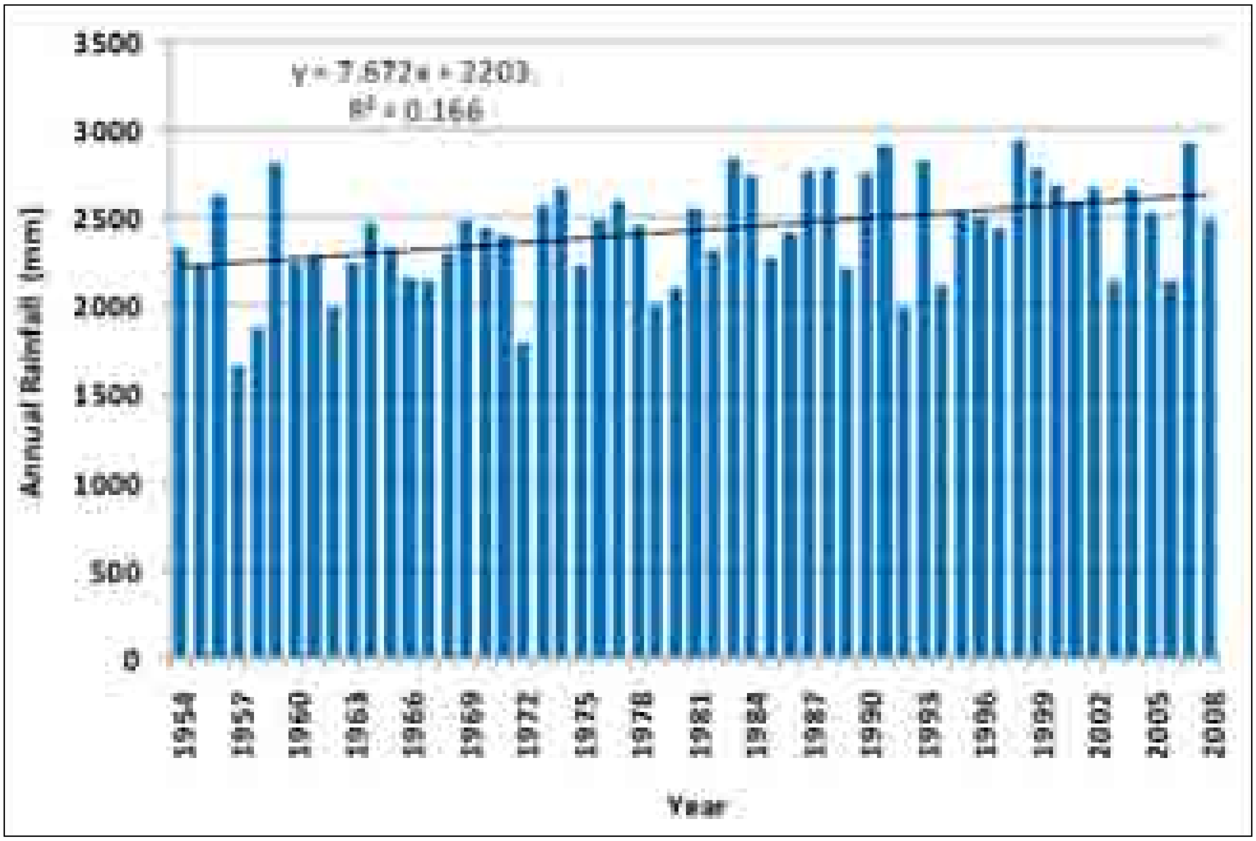


Figure 3. Trend in annual rainfall in Bangladesh.
Source: BMD 2010.

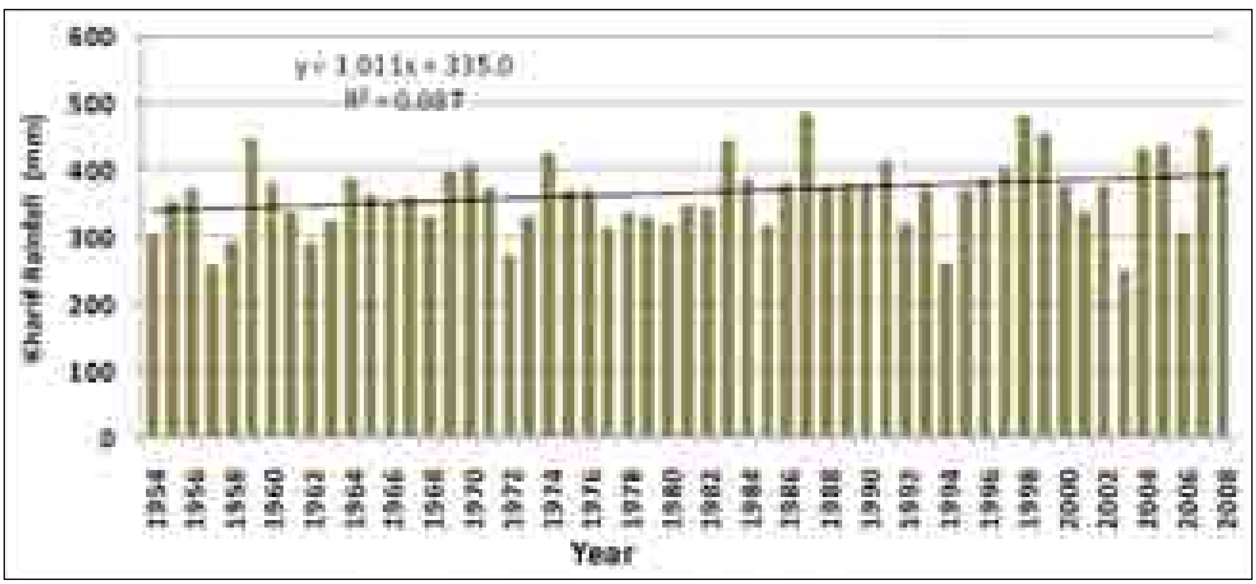


Figure 4. Kharif *rainfall trend (1954-2008).*
Source: BMD 2010.

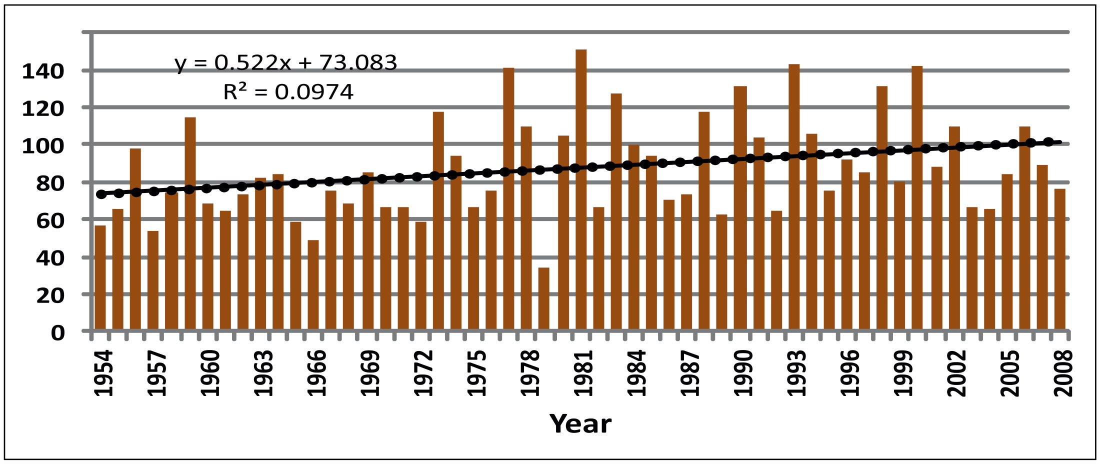


Figure 5. Amount of rainfall in rabi *and pre-*kharif *season (Jan-May).*
Source: BMD 2010.

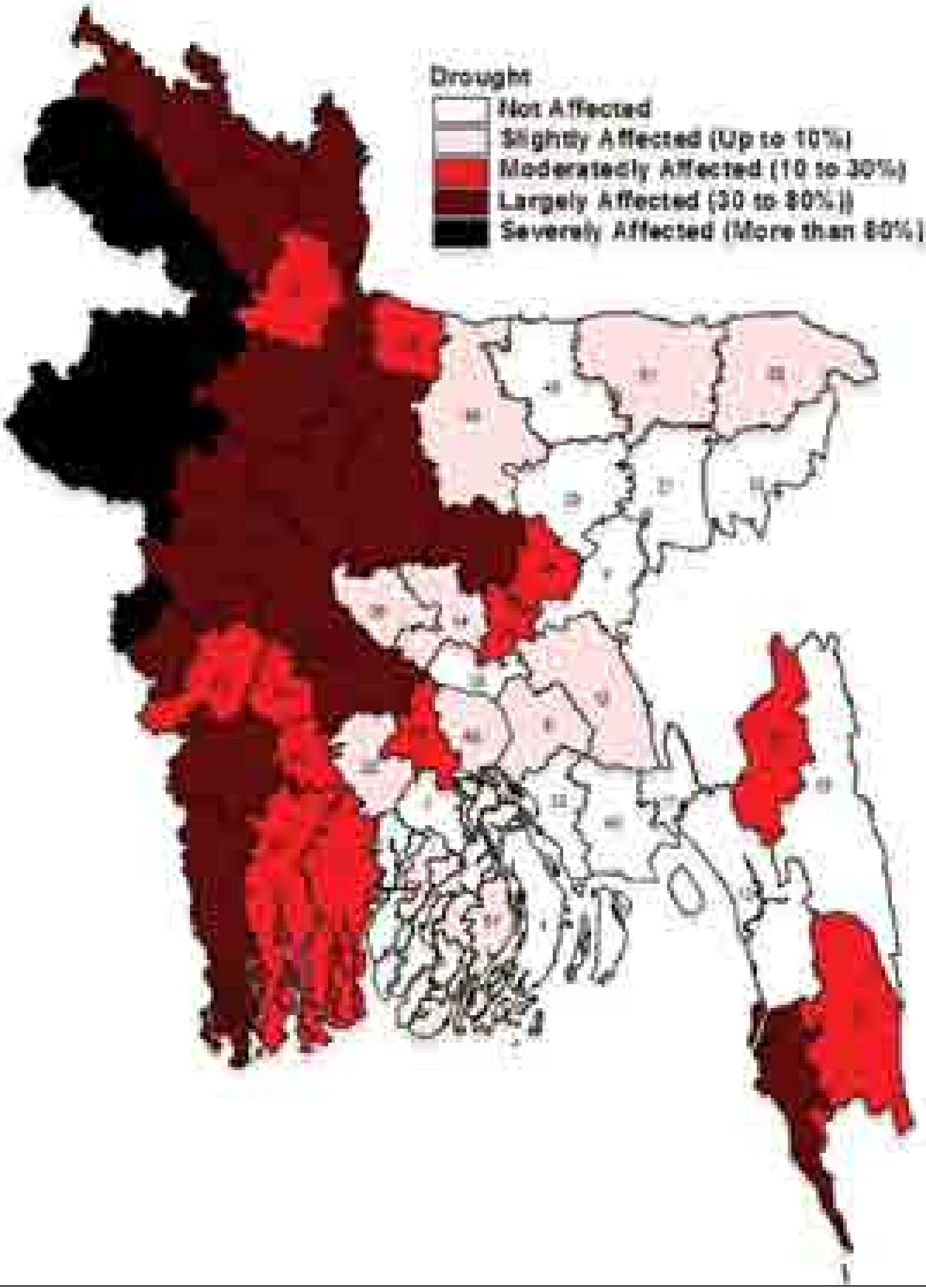
With respect to future vulnerability to drought, Deb et al. (2009) found that the intensity and severity of drought will increase in Bangladesh by 2030. As per their findings, another 22 districts would be added to the list of drought affected areas in the country with 12 in moderately affected areas and 10 districts in slightly drought-prone areas by 2030 (Map 8). Similarly, Ahmed and Alam (1998) predicted an increase in the average temperature by 1.3°C by 2030, and by the year 2075 it is expected to rise by 2.6°C. As per the forecasting made by the National Adaptation Programme for Action (NAPA), the average temperature would increase by 1°C, 1.4°C, and 2.4°C by the years 2030, 2050 and 2100, respectively.

According to NAPA (2005), it is forecasted that 55 to 62% of rice yields (58.5%) in Bangladesh would be affected by drought by the year 2030. Moreover, it is anticipated that about 24.3% of the total crop production would be lost due to the same reason in the same time period. Deb et al. (2009) also noted that about 9.98 million hectares (67.58%) of land in Bangladesh was affected by the *rabi* drought in 2000, and this figure is expected to increase by 3.27% by 2030. In other words, an additional 0.327 million hectares of land will become drought-prone by 2030 and the total drought-prone areas will be 69.79% (10.31 million hectares) of the total landmass of Bangladesh due to *rabi* drought by the year 2030. The study also estimated that due to drought, about 2.43% of the total rice production would be decreased in Bangladesh by the same time.

5. Changes in General Climatic Characteristics in Farm level Study Areas

In order to investigate the farm level changes in general climatic characteristics, the study has selected four villages from two different agro-ecological zones of Bangladesh. Nishaiganj of Mymensingh and Paschim Bahadurpur of Madaripur were selected from flood prone zones, whilst Baikunthapur of Thakurgaon and Khudiakhali of Chuadanga were selected from drought prone zones. Due to the unavailability of village level climatic data we used *upazila* (third largest administrative division in Bangladesh) level and nearby BMD station data as proxies.

Drought Affected Districts in 2030



Map 8. Drought-prone districts in Bangladesh in the year 2030.

Source: Deb et al. 2009.

Following this criterion, the data of Chuadanga Sadar was used for Khudiakhali village, Bhaluka for Nishaiganj village, Madaripur Sadar for Paschim Bahadurpur village and Thakurgaon Sadar for Baikunthapur village. In some cases, the data of BMD station Dinajpur was used as a proxy for Baikunthapur village, Rajsahi as Khudiakhali, Mymensingh as Nishaiganj, and Madaripur as Paschim Bahadurpur village.

Rainfall

The analysis of rainfall in flood prone villages reveals that the annual rainfall in Paschim Bahadurpur village was below the average climatic normal level since 2000, which continued until 2008. The rainfall in Nishaiganj village has observed a cyclical pattern since 1971, though it has started to decline marginally since the late 1990s. Conversely, the annual rainfall in drought prone Baikunthapur village has been continuously decreasing since the mid-1980s.The observed amount of rainfall in Khudiakhali village was always lower than the average climatic normal level in the 1970s. After that, the village started to observe a cyclical pattern in rainfall, which continued till 2008.

The amount of rainfall in drought prone Thakurgaon Sadar has ranged between 2000 to 2200 mm throughout the 1971-2008 period, whilst it ranged between 1500 and 1800 mm in another drought prone area, Chuadanga Sadar (Map 9). The rainfall in Madaripur Sadar was between 2000 and 2200 mm in the last four decades while it varied from 1800 mm to 2800 mm during 1971-2008 in Bhaluka.

The analysis of the number of rainy days shows that the annual rainy days have decreased during the 2001-2008 period in drought prone villages, and has increased in flood prone villages. The rate of decrease in Baikunthapur village was almost 23% during this period. However, the decrease in Khudiakhali village was not as much (3%) as the increase in Nishaiganj and Paschim Bahadurpur Villages (6 and 9% respectively). The number of rainy days in the observed periods was greater than the normal number of rainy days disregarding drought or flood prone areas.

The seasonal variation in the number of rainy days was cyclical in the last four decades. It has decreased by 11% and 6% respectively in Baikunthapur and Khudiakhali village and increased by 9% in both of the flood prone villages.

The number of rainy days has declined by 45% during the post-monsoon season in drought prone Baikunthapur and remained stagnant in Khudiakhali village. On the other hand, it has increased by 13% in flood prone Nishaiganj and remained stagnant in Paschim Bahadurpur village. However, the number of rainy days was always higher than the normal level irrespective of zone and period during the post-monsoon season.

In winter, the actual rainy days were lower than the normal climatic rainy days in all four villages during the periods of 1971-2000 and 2001-2008. The number of rainy days increased by 17% in the drought prone village Baikunthapur; whereas it decreased drastically by 150% in another drought prone village, Khudiakhali. In the same way, it increased by 17% in the flood prone village Nishaiganj, and decreased by 14% in another flood prone village, Paschim Bahadurpur, during the periods being compared.

The analyzed results of probability of occurrence of rainfall in these districts are given in the annexures. Analysis results of Mymensingh, Dinajpur, Faridpur, Madaripur (Annexure 1) showed that the probability of occurrence varies during the rainy season, which spread between 0 and 1. During the rainy season the occurrence of W/W is high and vice versa D/D is high during the summer season. However, there are weekly experiences of droughts represented by greater probability of dry weeks and also occurrence of extreme events of rainfall during the odd season. This shows the instance of intra-seasonal drought and extreme rainfall that could result in the crop loss and resulting yield.

The heavy rainfall events, ie, receiving more than normal amounts of rain in a day, has been analyzed for all the study districts of Bangladesh (Table 5, 6, 7). In Dinajpur, the instance of receiving >100 mm per day has shown an increasing trend over the years. There has also been an insignificant increasing trend in rainfall events during the winter season (Annexure 2). Complete result tables of heavy rainfall analysis of Madaripur (Annexure 3), Rajshahi (Annexure 4), Mymensingh (Annexure 5) are also appended along with this report.

Table 5. Number of rainy days (>100mm).

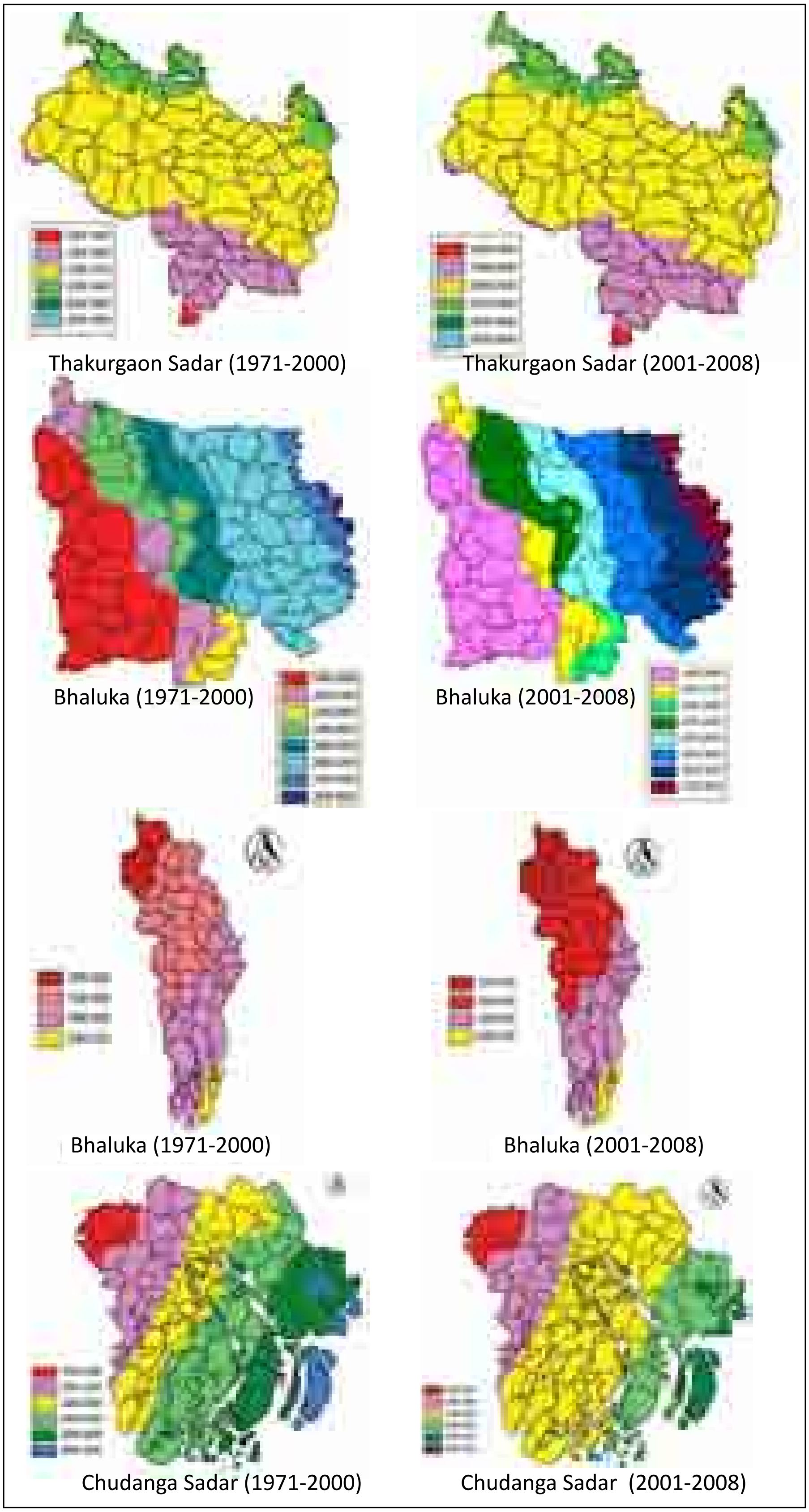
	Station				
Year	Dinajpur	Faridpur	Madaripur	Mymensingh	Rajshahi
1970	-	0	-	-	-
1971	-	0	-	-	-
1972	-	1	-	-	-
1973	-	2	-	-	-
1974	-	1	-	-	1
1975	-	1	-	-	0
1976	-	3	-	-	1
1977	-	1	-	3	2
1978	-	2	-	1	2
1979	-	4	-	0	2
1980	-	0	-	2	1
1981	1	5	0	2	1
1982	1	0	0	4	0
1983	2	1	0	8	4
1984	2	5	1	2	1
1985	3	0	4	0	0

Continued

Table 5. Number of rainy days (>100mm) *continued*.

Year	Station				
	Dinajpur	Faridpur	Madaripur	Mymensingh	Rajshahi
1986	2	2	8	6	0
1987	5	4	3	3	0
1988	2	3	2	4	0
1989	5	1	0	2	0
1990	2	1	0	2	0
1991	3	0	2	4	1
1992	3	0	0	1	0
1993	3	1	2	4	1
1994	0	1	0	0	0
1995	6	5	3	1	0
1996	3	1	1	1	0
1997	2	0	0	2	3
1998	3	0	1	2	0
1999	3	3	3	0	1
2000	1	0	1	1	3
2001	5	0	2	3	1
2002	4	3	2	2	0
2003	2	0	0	2	1
2004	3	2	4	5	1
2005	7	1	3	2	1
2006	0	4	1	1	0
2007	1	2	3	3	3
2008	0	1	0	5	1

'-' Data not available



Map 9. Distribution of mean rainfall in studied area in 1971-2000 and 2001-2008.

Table 6. Annual rainfall in the study districts (mm).

Year	Dinajpur	Faridpur	Madaripur	Mymensingh	Rajshahi
1970	-	-	-	-	-
1971	-	-	-	-	-
1972	-	1642	-	-	-
1973	-	2599	-	-	-
1974	-	2211	-	-	1736
1975	-	1974	-	-	1144
1976	-	1924	-	-	1427
1977	-	2039	-	2847	1918
1978	-	1479	-	1924	1734
1979	-	1809	-	958	1548
1980	-	2072	-	2321	1576
1981	2117	2599	-	2187	2241
1982	1342	1410	-	2354	1103
1983	2100	2251	-	2840	1629
1984	2165	2544	1304	2679	1575
1985	2097	1482	1407	1559	-
1986	1944	2319	1503	2971	-
1987	3179	1993	1508	2209	-
1988	2221	2183	1608	3209	541
1989	1913	1438	1663	2274	1325
1990	2081	1985	1679	2439	1767
1991	2012	2156	1847	3312	1498
1992	1649	1336	1905	1584	843
1993	2179	2256	1917	3213	1623
1994	1142	1344	2041	1604	1142
1995	2613	2006	2061	2645	1432
1996	2045	1810	2087	1620	1269
1997	1809	1548	2099	2208	2062
1998	2391	1818	2127	2347	1540
1999	2536	2105	2165	2174	1862
2000	1515	1952	2184	2317	1690
2001	2173	1634	2189	1948	1382
2002	2553	2179	2200	2432	1445

Continued

Table 6. Annual rainfall in the study districts (mm) *continued*.					
Year	Dinajpur	Faridpur	Madaripur	Mymensingh	Rajshahi
2003	2057	1400	2221	1813	1412
2004	2293	2001	2246	3193	1786
2005	2975	1650	2379	2672	1405
2006	1285	1649	2390	1961	1145
2007	1579	2040	2511	2782	2018
2008	1772	1443	2770	2239	1315
Average	2062	1899	2000	2339	1504

'-' Data not available

Table 7. Probability (%) of drought in Bangladesh.					
Type	Dinajpur	Faridpur	Madaripur	Mymensingh	Rajshahi
Mild	31	32	27	38	41
Moderate	14	11	12	13	6
Severe	0	0	0	3	3

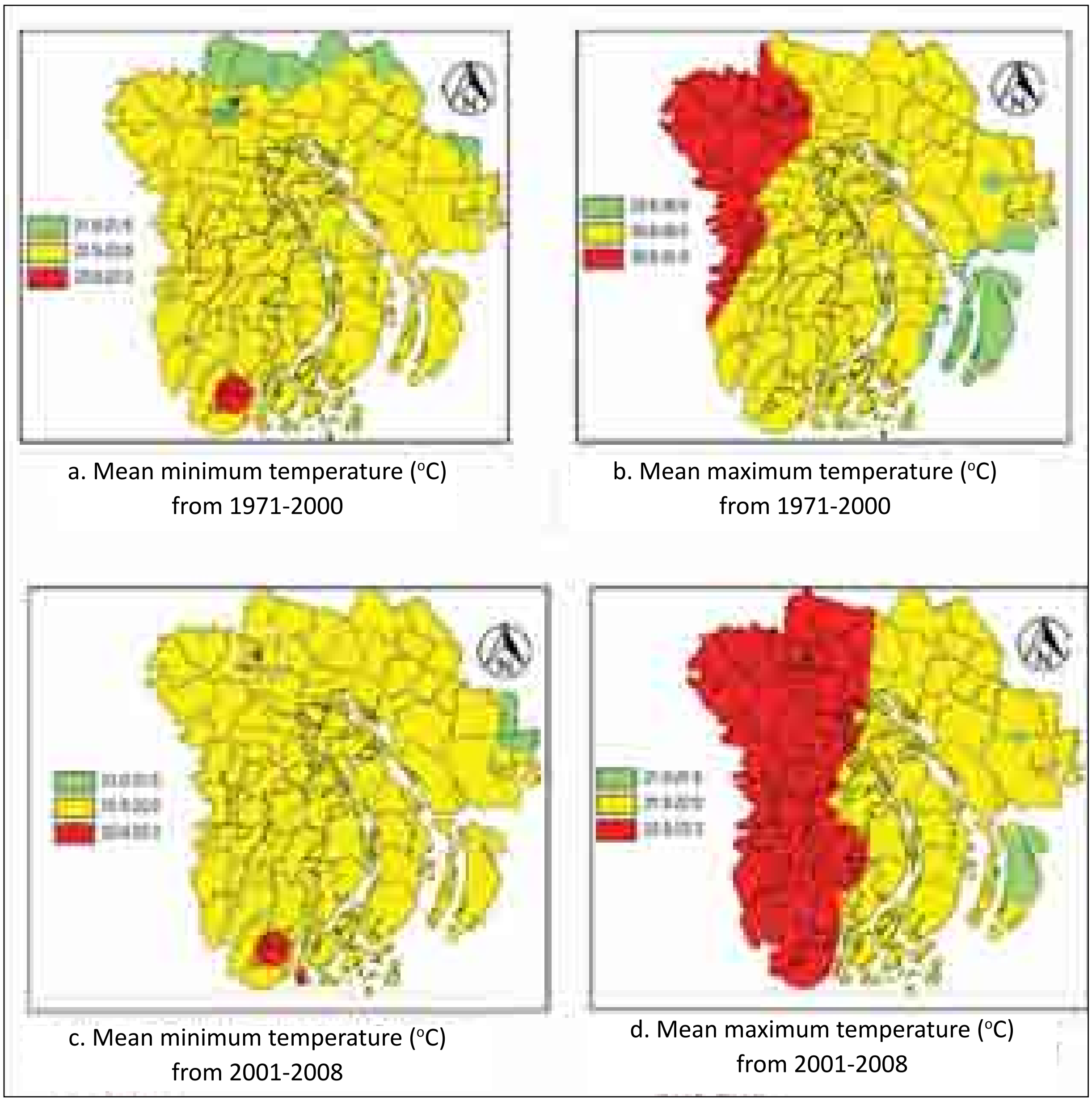
Temperature

Flood prone villages

The monthly minimum temperature has increased significantly in both Paschim Bahadurpur and Nishaiganj villages during the two study periods of 1971-2000 and 2001-2008 (Map 10 and 11). During 1971-2000 the highest minimum temperature in Nishaiganj village was 25.98^{o}C, which had increased to 27.09^{o}C in 2001-2008. In the case of Paschim Bahadurpur, it was 26.07^{o}C and increased to 26.37^{o}C during the two periods. The fluctuation in the minimum temperature was more visible in Nishaiganj than Paschim Bahadurpur village where the rate of fluctuation has intensified in recent years. However, the overall fluctuation in minimum temperature has increased in the recent years in both villages with varied intensities. The range of CV in Nishaiganj village during 1971-2000 was 1.98 to 7.22, which had increased from 6.77 to 27.90 in 2001-2008. On the other hand, the range of CV in Paschim Bahadurpur village during 1971-2000 fluctuated from 1.74 to 7.62, and the gap widened from 0.45 to 11.71 in 2001-2008. The fluctuation in minimum temperature was more visible in winter season in both of the villages in recent times. The winter season CV during 2001-2008 in Nishaiganj village ranged from 24.33 to 27.90, which varied from 6.24 to 7.22 during 1971-2000.

The monthly maximum temperature was more or less stagnant throughout the last four decades in both Paschim Bahadurpur and Nishaiganj village. During 1971-2000 the highest maximum temperature in Nishaiganj village was 32.38^{o}C, which decreased marginally to 31.70 during 2001-2008. The highest level of maximum temperature also decreased in Paschim

Bahadurpur village. It was 34.10°C during 1971-2000 and decreased to 33.07 in 2001-2008. The fluctuation in maximum temperature increased in the recent years in Nishaiganj village though it had remained stagnant throughout the last four decades in Paschim Bahadurpur village. The CV of maximum temperature in Nishaiganj village was 1.80 to 4.48 during 1971-2000, and the difference widened from 2.96 to 14.13 during 2001-2008; whereas it ranged from 1.35 to 5.82 during 1971-2008 in Paschim Bahdurpur village. The highest maximum temperature in both the flood prone villages of Bangladesh was observed during the month of April in the last forty years.



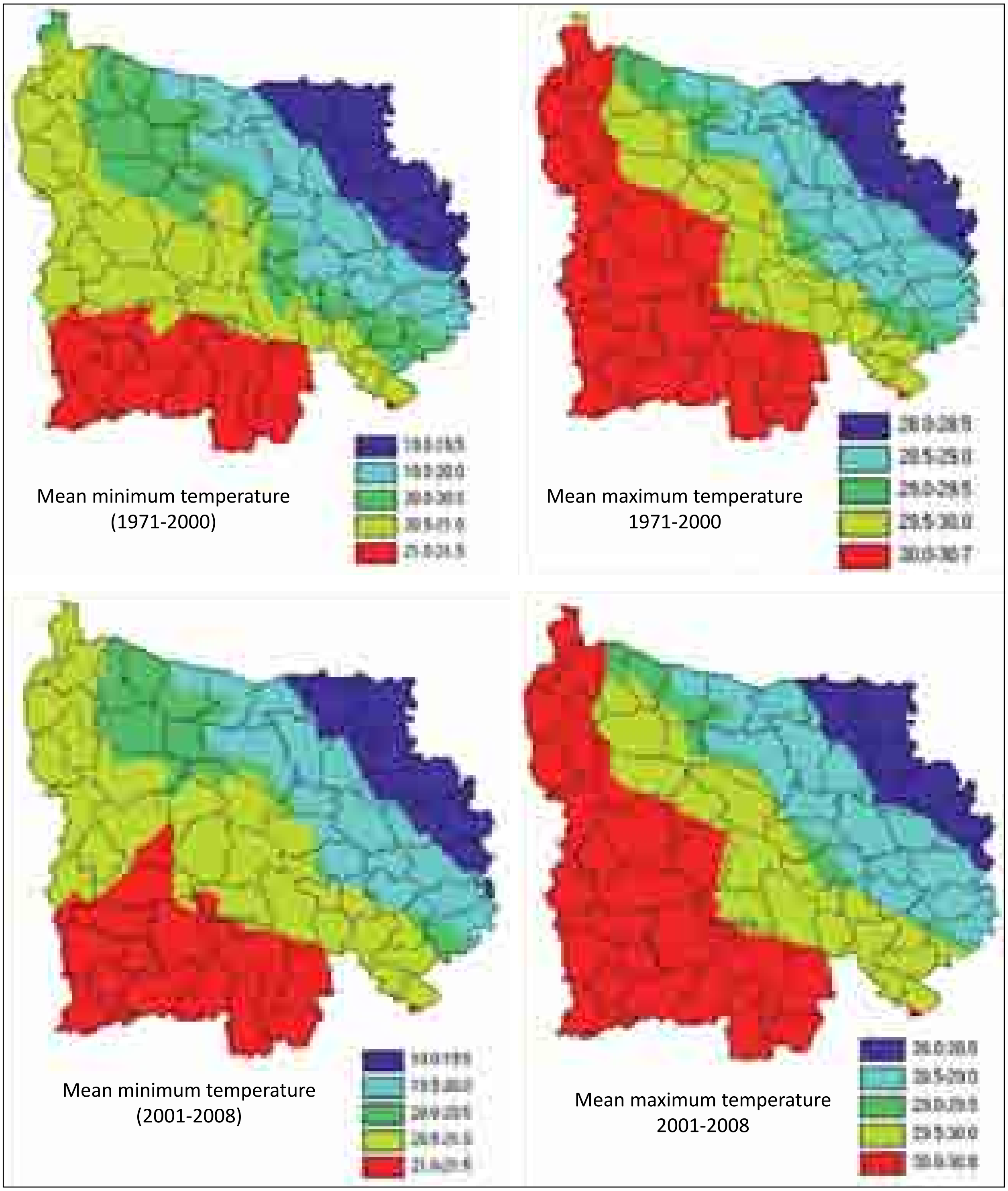
a. Mean minimum temperature (°C) from 1971-2000

b. Mean maximum temperature (°C) from 1971-2000

c. Mean minimum temperature (°C) from 2001-2008

d. Mean maximum temperature (°C) from 2001-2008

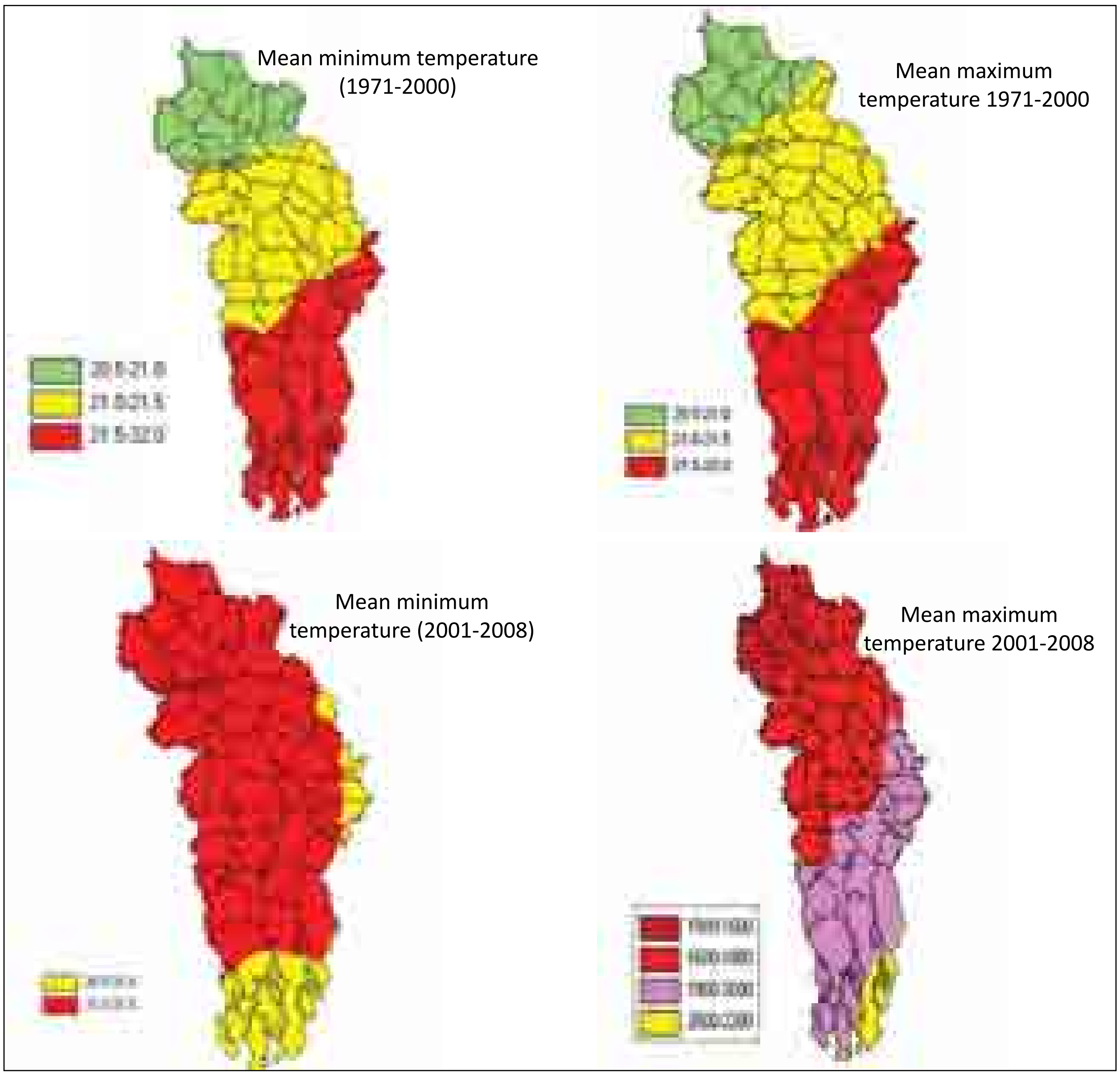
Map 10. Distribution of mean minimum and maximum temperature (°C) in Madaripur Sadar.



Map 11. Distribution of mean minimum and maximum temperature (°C) in Bhaluka.

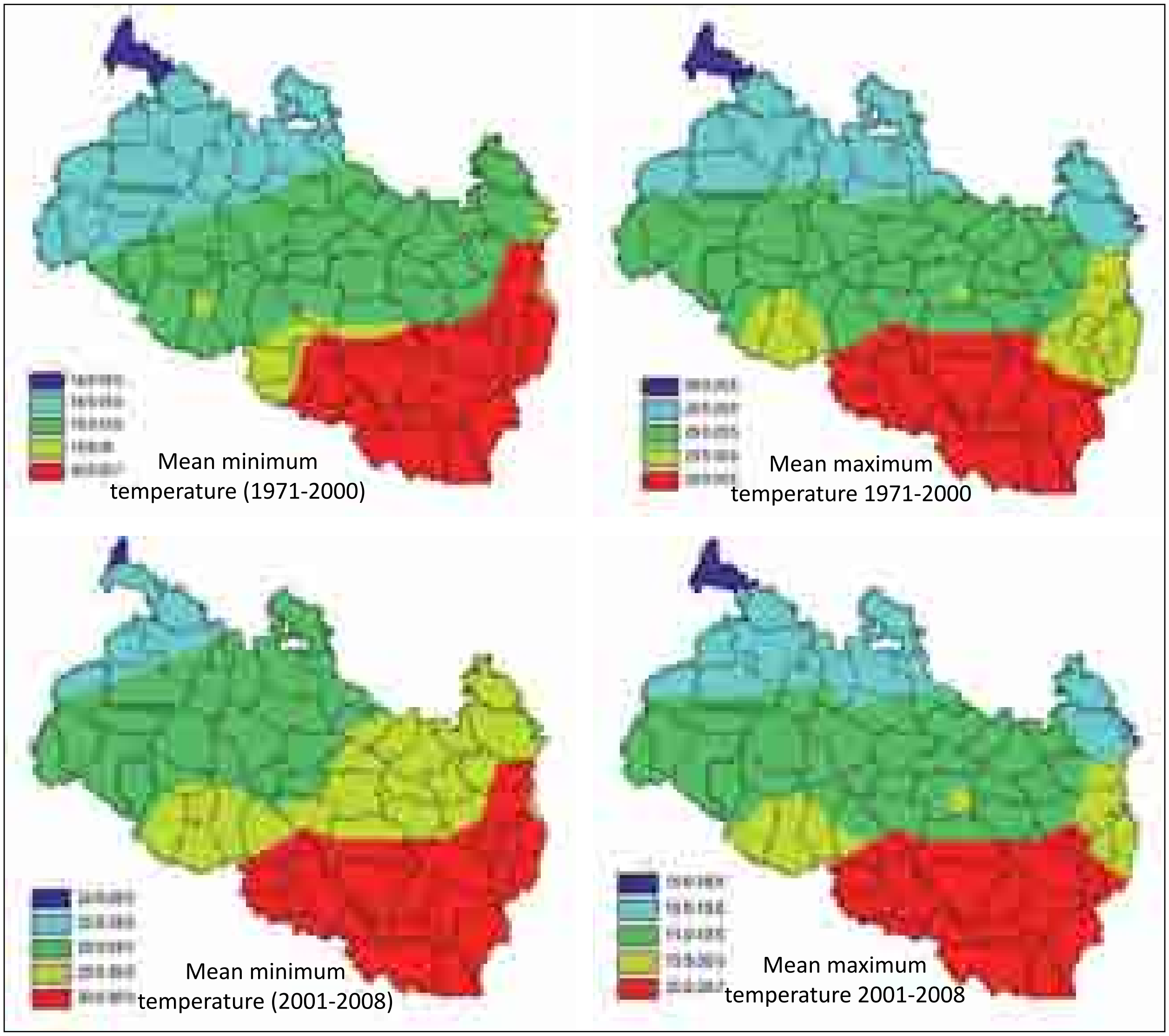
Drought prone villages

The monthly minimum average temperature in both drought prone villages (Baikunthapur of Thakurgaon and Khudiakhali of Chuadanga districts) has increased significantly in the recent years of 2001-2008 (Map 12 and 13). The highest minimum temperature in Baikunthapur increased from 26.01°C in 1971-2008 to 27.39°C in 2001-2008; whereas it had increased from 26.02°C to 27.36°C in Khudiakhali village during the compared periods. The overall fluctuation in minimum temperature also increased drastically during the period 2001-2008 in both the villages. Even though the range of CV of monthly minimum average temperature in Baikunthapur village during 1971-2000 was 1.22 to 8.51, it increased from 8.67 to 30.39 in 2001-2008. Similarly, the CV of Khudiakhali village has increased from the range of 1.57-9.18 to 9.21-33.05 in the compared periods. The fluctuations were more visible during the months of December to February.



Map 12. Distribution of mean minimum and maximum temperature (°C) in Chuadanga Sadar.

The monthly maximum average temperature had decreased marginally during the period of 2001-2008 in Baikunthapur village though it was more or less stagnant in Khudiakhali village. The highest maximum average temperature in Baikunthapur village decreased from 33.55°C in 1971-2000 to 32.44°C in 2001-2008. In the case of Khudiakhali, it had decreased from 35.79°C to 35.34°C in the compared periods. Very little fluctuation were observed in the monthly maximum temperature in both of the drought prone villages. The CV in Khudiakhali was 1.94 to 4.63 during 1971-2000, and ranged from 2.58 to 6.55 during 2001-2008. Similarly, in Baikunthapur village, it ranged between 2.17 to 4.67 during 1971-2000 and 3.44 to 5.69 during 2001-2008.



Map 13. Distribution of mean minimum and maximum temperature (°C) in Thakurgaon Sadar.

Concluding Remarks

From the study it clearly emerges that Bangladesh's climate has experienced significant changes over the last forty years, since the country gained independence in 1971. The change is visible in terms of most of the climatic indicators, and what is more significant, the rate of change has intensified in recent years. The quantum of rainfall has increased in the last decade for most of the agro-ecological zones of the country. However, it is also important to note that the number of rainy days is on the decline on a continuing basis. Both minimum and maximum temperatures have been increasing over a period of time. The rate of increase in minimum temperature is higher than the rate of increase in maximum temperature. The study found that the rainfall and temperature have become more erratic in the recent years. The frequency of floods has decreased but their intensity has tended to increase. The rate and intensity of flash floods have increased at an alarming scale. Although the incidence of severe drought has decreased, in some instances it has risen drastically.

The observed changes in major climatic characteristics have already started to have adverse implications for the life and livelihoods of the people of Bangladesh. To mitigate the climate change driven adversities, Bangladesh needs to design a comprehensive climate adaptation plan for both the short and long term perspectives, which will clearly define appropriate implementation strategies.

In order to mitigate the negative impacts of climate change on agriculture and to facilitate adaptation in the future, it is important that research capacities in Bangladesh for developing drought-, flood- and saline-tolerant crop varieties is strengthened significantly. In addition, adequate investment in a gradual move towards the use of biotechnology, GIS, remote sensing and ICT will be required for generation and dissemination of technology. Long-term weather forecasting along with crop production and crop husbandry augmenting recommendations, will also be helpful in terms of assisting the farmers to adapt to the changed climatic condition.

Bangladesh needs to concentrate on the establishment of different crop production zones throughout the country. Since northern drought-prone areas are likely to face more droughts, it is necessary to adopt a pragmatic strategy to transform this region into a non-rice crop growing zone, particularly in the dry season. In the winter, cultivation of crops that require small quantities of water for cultivation (such as chickpea, lentil, maize) may be promoted in this region as part of the adaptation strategy. Water efficient and drought tolerant high value horticultural crops (mango, jujube, guava, custard apple, sweet tamarind) need to be promoted throughout the year. In the southern region, cultivation of Boro paddy using surface water will need to be accelerated.

Bangladesh Rice Research Institute (BRRI) has developed several salt-tolerant rice varieties such as BR 10, BR 23, BRRI Dhan 41 and BRRI 47. However, with the changed climatic conditions, it needs to develop more new varieties since salinity levels are forecasted to increase further in the future. To face the challenges of prolonged submergence, development of submergence-tolerant varieties is also essential. BRRI has been conducting research on submergence tolerance varieties (Swarna Sub2); such research ought to be continued and encouraged.

In the coastal belt, Malaysian dwarf coconut trees may be researched and promoted to minimize the risk of damage by cyclones. Development of eco-specific adaptive knowledge (including indigenous knowledge) to cope with climate variability will be needed to enhance adaptive capacity. Bangladesh can draw significant synergies from strengthening partnership with international agricultural research and development organizations (such as IRRI, ICRISAT, CIMMYT and FAO) and other SAARC countries in the areas of agricultural research and development.

References

Agrawala S, Ota T, Ahmed AU, Smith J and **Aalst MV.** 2003. Development and Climate Change in Bangladesh: Focus on Coastal Flooding and the Sundarbans. Paris: Organisation for Economic Co-operation and Development (OECD).

Ahmad QK, Chowdhury AKA, Imam SH and **Sarker M**. 2000. Perspectives on Flood 1998. Dhaka: The University Press Limited (UPL). 142 pp.

Ahmad QK, Ahmad N and **Rasheed KBS**. 1994. Resources, Environment and Development in Bangladesh with Particular Reference to the Ganges, Brahmaputra and Meghna Basins. Dhaka: Academic Publishers. 134 pp.

Ahmed AU. 2006. Bangladesh: Climate Change Impacts and Vulnerability—A Synthesis. Climate Cell, Department of Environment, Government of Bangladesh.

Ahmed AU and **Alam M**. 1998. Development of Climate Change Scenarios With General Circulation Models. Pages 13-20 *in* Vulnerability and Adaptation to Climate Change for Bangladesh (Huq S, Karim Z, Asaduzzaman M and Mahtab F, eds.). Dordrecht: Kluwer Academic Publishers.

Ahmed AU and **Haque N**. 2002. Climate Change and Sustainable Development. *In* Citizens' Perspectives on Sustainable Development (Ahmad QK and Ahmed AU, eds.). Dhaka: Bangladesh Unnayan Parishad (BUP).

Ahmed AU and **Mirza MMQ**. 2000. Review of Causes and Dimensions of Floods with Particular Reference to Flood '98: National Perspectives. Page 142 *in* Perspectives on Flood 1998 (Ahmad QK, Chowdhury AKA, Imam SH and Sarker M, eds.). Dhaka: The University Press Limited.

Alam M, Nishat A and **Siddiqui SM**. 1998. Water Resources Vulnerability to Climate Change With Special Reference to Inundation. Pages 21-38 *in* Vulnerability and Adaptation to Climate Change for Bangladesh (Huq S, Karim Z, Asaduzzaman M and Mahtab F, eds.). Dordrecht: Kluwer Academic Publishers.

Anwar A. 1999. Climate change impacts and adaptation assessment in Bangladesh. *Climate Research* 12: 109-116.

Banglapedia. 2010. Available at: http://www.banglapedia.org/httpdocs/Atlas/bangladesh.htm

BBS. 2010. Bangladesh Bureau of Statistics. Parishankhyan Bhaban, E-27/A, Agargaon Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh.

BCCSAP. 2009. Bangladesh Climate Change Strategy and Action Plan 2009. Ministry of Environment and Forests, Government of Bangladesh (GoB).

BIWTA. 2011. Bangladesh Inland Water Transport Authority. Available at: http://www.biwta.gov.bd/about_us.htm, accessed on 13 January, 2011.

BMD. 2010. Bangladesh meteorological department. http://www.bmd.gov.bd/

CCC. 2009. Economic modeling of climate change adaptation needs for physical infrastructure in Bangladesh. DOE, MOEF, Government of Bangladesh.

CEGIS. 2006. Impacts of Sea Level Rise on Land-use Suitability and Adaptation Options. Draft Submitted to the Ministry of Environment and Forests, Government of Bangladesh (GOB) and United Nations Development Programme (UNDP) by Centre for Environmental Geographic Information Services (CEGIS), Dhaka

DAE. 2009. Department of agricultural extension. Government of Bangladesh http://www.dae.gov.bd/

Deb U, Nazrul Islam AKM, Khaled N, Nabi A, Al Amin M, Golam Ahmad M, Tasnima K and **Rudra Paul DN.** 2009. Climate Change and Rice Production in Bangladesh: Implications for R&D Strategy in Proceedings of Conference on Climate Change and Bangladesh Development Strategy: Domestic Tasks and International Cooperation, Organized by BAPA, Dhaka.

Deb U. 2005. Trade Liberalisation and Bangladesh Agriculture: Impacts on Cropping Pattern, Resource Use Efficiency and Effective Incentives. A Report prepared at the Centre for Policy Dialogue (CPD) under Research Programme-IV of the South Asia Network of Economic research Institutes (SANEI). Mimeo

DoE. 2007. Department of environment. Government of Bangladesh, http://www.doe-bd.org/

GoB. 2009. Government of Bangladesh. http://www.bangladesh.gov.bd/

Gunter Bernhard G, Rahman A and **Ataur Rahman AFM**. 2008. How vulnerable are Bangladesh's indigenous people to climate change. Dhaka: Bangladesh Development Research Centre.

Hofer T. 1998. Floods in Bangladesh: A Highland-Lowland Interaction? Switzerland: Institute of Geography, University of Berne. 171 pp.

IPCC. 2001. Climate Change 2001: Synthesis Report. Geneva: Intergovernmental Panel on Climate Change (IPCC).

IPCC. 2007. Climate Change 2007: Synthesis Report. Geneva: Intergovernmental Panel on Climate Change (IPCC).

Karim Z, Hussain SG and **Ahmed M.** 1996. Assessing Impacts of Climate Variations on Foodgrain Production in Bangladesh, Water, Air and Soil Pollution 92: 53-62.

Mirza MMQ and **Dixit A.** 1997. Climate Change and Water Resources in the GBM Basins, Water Nepal 5(1): 71-100.

Mirza, MMQ, Dixit A and **Nishat A.** 2003. Flood Problem and Management in South Asia. Dordrecht: Kluwer Academic Publishers.

NAPA. 2005. National Adaptation Programme of Action (NAPA), Ministry of Environment and Forests, Government of the People's Republic of Bangladesh (GOB), Dhaka, 48 pp.

Ramamasy S and **Bass S**. 2007. A Case Study on Climate variability and Change: Adaptation to Drought in Bangladesh. A Resource Book and Training Guide, Asian Disaster Preparedness Center (ADPC) and Food and Agriculture Organization (FAO), Rome, Italy.

SPARRSO. 2010. Bangladesh Space Research and Remote Sensing Organization.

UNDP. 2004. Reducing Disaster Risk: A challenge for Development. Available at http:\\www.undp.org/bcpr.

Annexures

Annexures 1

Initial and conditional probabilities of rainfall – Mymensingh

Initial and conditional probabilities of rainfall						
(Markov chain probability) Limit = 10						
	Initial probabilities		Conditional probabilities			
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	1	1	0
2	0.0625	0.9375	0	0	0.9375	0.0625
3	0.0313	0.9688	0	1	0.9667	0.0333
4	0.0313	0.9688	0	1	0.9677	0.0323
5	0.1875	0.8125	1	0	0.8387	0.1613
6	0.0938	0.9063	0.3333	0.6667	0.9615	0.0385
7	0.1563	0.8438	0	1	0.8276	0.1724
8	0.2188	0.7813	0.2	0.8	0.7778	0.2222
9	0.2188	0.7813	0.2857	0.7143	0.8	0.2
10	0.0938	0.9063	0.2857	0.7143	0.96	0.04
11	0.1875	0.8125	0.3333	0.6667	0.8276	0.1724
12	0.2813	0.7188	0.3333	0.6667	0.7308	0.2692
13	0.4688	0.5313	0.4444	0.5556	0.5217	0.4783
14	0.5313	0.4688	0.6667	0.3333	0.5882	0.4118
15	0.6563	0.3438	0.7647	0.2353	0.4667	0.5333
16	0.7188	0.2813	0.8095	0.1905	0.4545	0.5455
17	0.9063	0.0938	0.913	0.087	0.1111	0.8889
18	0.8125	0.1875	0.8276	0.1724	0.3333	0.6667
19	0.8438	0.1563	0.8462	0.1538	0.1667	0.8333
20	0.9063	0.0938	0.8889	0.1111	0	1
21	0.9375	0.0625	0.931	0.069	0	1
22	0.875	0.125	0.8667	0.1333	0	1
23	0.9688	0.0313	0.9643	0.0357	0	1
24	0.9688	0.0313	0.9677	0.0323	0	1
25	0.9688	0.0313	0.9677	0.0323	0	1
26	1	0	1	0	0	1
27	0.9688	0.0313	0.9688	0.0313	0	0

Continued

Continued

(Markov chain probability) Limit = 10						
WEEK	Initial probabilities		Conditional probabilities			
	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
28	0.9375	0.0625	0.9355	0.0645	0	1
29	1	0	1	0	0	1
30	1	0	1	0	0	0
31	1	0	1	0	0	0
32	0.9063	0.0938	0.9063	0.0938	0	0
33	0.9688	0.0313	0.9655	0.0345	0	1
34	0.9688	0.0313	0.9677	0.0323	0	1
35	0.9688	0.0313	0.9677	0.0323	0	1
36	0.9063	0.0938	0.9032	0.0968	0	1
37	0.9375	0.0625	0.9655	0.0345	0.3333	0.6667
38	0.875	0.125	0.8667	0.1333	0	1
39	0.8125	0.1875	0.8214	0.1786	0.25	0.75
40	0.8438	0.1563	0.8462	0.1538	0.1667	0.8333
41	0.5938	0.4063	0.6296	0.3704	0.6	0.4
42	0.5625	0.4375	0.5789	0.4211	0.4615	0.5385
43	0.2188	0.7813	0.1667	0.8333	0.7143	0.2857
44	0.125	0.875	0.2857	0.7143	0.92	0.08
45	0.0938	0.9063	0.25	0.75	0.9286	0.0714
46	0.0938	0.9063	0	1	0.8966	0.1034
47	0.0313	0.9688	0	1	0.9655	0.0345
48	0.0625	0.9375	0	1	0.9355	0.0645
49	0	1	0	1	1	0
50	0.0938	0.9063	0	0	0.9063	0.0938
51	0.0313	0.9688	0	1	0.9655	0.0345
52	0.0938	0.9063	0	1	0.9032	0.0968

(Markov chain probability) Limit = 20						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	1	1	0
2	0.0313	0.9688	0	0	0.9688	0.0313
3	0	1	0	1	1	0
4	0	1	0	0	1	0
5	0.0938	0.9063	0	0	0.9063	0.0938
6	0.0625	0.9375	0	1	0.931	0.069
7	0.125	0.875	0	1	0.8667	0.1333
8	0.125	0.875	0.25	0.75	0.8929	0.1071
9	0.0313	0.9688	0.25	0.75	1	0
10	0.0625	0.9375	0	1	0.9355	0.0645
11	0.0938	0.9063	0.5	0.5	0.9333	0.0667
12	0.1875	0.8125	0	1	0.7931	0.2069
13	0.25	0.75	0.1667	0.8333	0.7308	0.2692
14	0.3438	0.6563	0.375	0.625	0.6667	0.3333
15	0.5625	0.4375	0.5455	0.4545	0.4286	0.5714
16	0.5625	0.4375	0.6111	0.3889	0.5	0.5
17	0.6875	0.3125	0.6667	0.3333	0.2857	0.7143
18	0.7188	0.2813	0.6818	0.3182	0.2	0.8
19	0.75	0.25	0.7826	0.2174	0.3333	0.6667
20	0.875	0.125	0.875	0.125	0.125	0.875
21	0.9375	0.0625	0.9286	0.0714	0	1
22	0.8125	0.1875	0.8	0.2	0	1
23	0.9063	0.0938	0.9231	0.0769	0.1667	0.8333
24	0.7813	0.2188	0.7586	0.2414	0	1
25	0.9375	0.0625	0.96	0.04	0.1429	0.8571
26	0.9063	0.0938	0.9	0.1	0	1
27	0.9063	0.0938	0.8966	0.1034	0	1
28	0.9063	0.0938	0.8966	0.1034	0	1
29	0.875	0.125	0.8966	0.1034	0.3333	0.6667
30	0.9375	0.0625	0.9286	0.0714	0	1
31	0.9688	0.0313	0.9667	0.0333	0	1
32	0.7188	0.2813	0.7419	0.2581	1	0

Continued

Continued

(Markov chain probability) Limit = 20						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
33	0.7813	0.2188	0.7826	0.2174	0.2222	0.7778
34	0.8438	0.1563	0.84	0.16	0.1429	0.8571
35	0.9063	0.0938	0.8889	0.1111	0	1
36	0.7813	0.2188	0.7931	0.2069	0.3333	0.6667
37	0.875	0.125	0.88	0.12	0.1429	0.8571
38	0.8125	0.1875	0.7857	0.2143	0	1
39	0.7188	0.2813	0.8077	0.1923	0.6667	0.3333
40	0.6875	0.3125	0.6957	0.3043	0.3333	0.6667
41	0.5	0.5	0.5909	0.4091	0.7	0.3
42	0.5313	0.4688	0.625	0.375	0.5625	0.4375
43	0.1563	0.8438	0.0588	0.9412	0.7333	0.2667
44	0.0625	0.9375	0.2	0.8	0.963	0.037
45	0.0938	0.9063	0	1	0.9	0.1
46	0.0625	0.9375	0	1	0.931	0.069
47	0.0313	0.9688	0	1	0.9667	0.0333
48	0.0625	0.9375	0	1	0.9355	0.0645
49	0	1	0	1	1	0
50	0.0625	0.9375	0	0	0.9375	0.0625
51	0	1	0	1	1	0
52	0.0313	0.9688	0	0	0.9688	0.0313
(Markov chain probability) Limit = 30						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	1	1	0
2	0.0313	0.9688	0	0	0.9688	0.0313
3	0	1	0	1	1	0
4	0	1	0	0	1	0
5	0.0313	0.9688	0	0	0.9688	0.0313
6	0.0313	0.9688	0	1	0.9677	0.0323
7	0.0625	0.9375	0	1	0.9355	0.0645
8	0.125	0.875	0.5	0.5	0.9	0.1
9	0	1	0	1	1	0
10	0.0313	0.9688	0	0	0.9688	0.0313
11	0.0625	0.9375	0	1	0.9355	0.0645

Continued

Continued

(Markov chain probability) Limit = 30						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
12	0.1563	0.8438	0	1	0.8333	0.1667
13	0.1563	0.8438	0.2	0.8	0.8519	0.1481
14	0.25	0.75	0.2	0.8	0.7407	0.2593
15	0.4063	0.5938	0.375	0.625	0.5833	0.4167
16	0.4375	0.5625	0.4615	0.5385	0.5789	0.4211
17	0.5313	0.4688	0.5714	0.4286	0.5	0.5
18	0.6563	0.3438	0.5882	0.4118	0.2667	0.7333
19	0.6875	0.3125	0.7619	0.2381	0.4545	0.5455
20	0.7188	0.2813	0.7273	0.2727	0.3	0.7
21	0.8125	0.1875	0.8696	0.1304	0.3333	0.6667
22	0.7188	0.2813	0.7308	0.2692	0.3333	0.6667
23	0.8125	0.1875	0.8261	0.1739	0.2222	0.7778
24	0.6563	0.3438	0.6538	0.3462	0.3333	0.6667
25	0.8438	0.1563	0.8571	0.1429	0.1818	0.8182
26	0.8438	0.1563	0.8519	0.1481	0.2	0.8
27	0.8125	0.1875	0.8148	0.1852	0.2	0.8
28	0.875	0.125	0.8462	0.1538	0	1
29	0.8125	0.1875	0.8571	0.1429	0.5	0.5
30	0.8438	0.1563	0.8077	0.1923	0	1
31	0.8125	0.1875	0.8148	0.1852	0.2	0.8
32	0.6563	0.3438	0.6538	0.3462	0.3333	0.6667
33	0.75	0.25	0.7619	0.2381	0.2727	0.7273
34	0.75	0.25	0.75	0.25	0.25	0.75
35	0.8438	0.1563	0.8333	0.1667	0.125	0.875
36	0.75	0.25	0.7778	0.2222	0.4	0.6
37	0.7813	0.2188	0.7917	0.2083	0.25	0.75
38	0.6875	0.3125	0.68	0.32	0.2857	0.7143
39	0.625	0.375	0.6818	0.3182	0.5	0.5
40	0.5313	0.4688	0.6	0.4	0.5833	0.4167
41	0.4375	0.5625	0.4706	0.5294	0.6	0.4
42	0.4688	0.5313	0.5714	0.4286	0.6111	0.3889
43	0.125	0.875	0.0667	0.9333	0.8235	0.1765
44	0.0625	0.9375	0.25	0.75	0.9643	0.0357

Continued

Continued

(Markov chain probability) Limit = 30						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
45	0.0625	0.9375	0	1	0.9333	0.0667
46	0.0625	0.9375	0	1	0.9333	0.0667
47	0	1	0	1	1	0
48	0.0313	0.9688	0	0	0.9688	0.0313
49	0	1	0	1	1	0
50	0.0313	0.9688	0	0	0.9688	0.0313
51	0	1	0	1	1	0
52	0.0313	0.9688	0	0	0.9688	0.0313
(Markov chain probability) Limit = 40						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	1	1	0
2	0.0313	0.9688	0	0	0.9688	0.0313
3	0	1	0	1	1	0
4	0	1	0	0	1	0
5	0	1	0	0	1	0
6	0	1	0	0	1	0
7	0	1	0	0	1	0
8	0.0625	0.9375	0	0	0.9375	0.0625
9	0	1	0	1	1	0
10	0	1	0	0	1	0
11	0.0625	0.9375	0	0	0.9375	0.0625
12	0.1563	0.8438	0	1	0.8333	0.1667
13	0.125	0.875	0.2	0.8	0.8889	0.1111
14	0.1875	0.8125	0	1	0.7857	0.2143
15	0.3438	0.6563	0.3333	0.6667	0.6538	0.3462
16	0.4063	0.5938	0.5455	0.4545	0.6667	0.3333
17	0.4688	0.5313	0.3846	0.6154	0.4737	0.5263
18	0.5	0.5	0.4667	0.5333	0.4706	0.5294
19	0.6563	0.3438	0.75	0.25	0.4375	0.5625
20	0.625	0.375	0.6667	0.3333	0.4545	0.5455
21	0.75	0.25	0.8	0.2	0.3333	0.6667
22	0.625	0.375	0.7083	0.2917	0.625	0.375
23	0.625	0.375	0.65	0.35	0.4167	0.5833

Continued

Continued

(Markov chain probability) Limit = 40						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
24	0.625	0.375	0.7	0.3	0.5	0.5
25	0.7813	0.2188	0.75	0.25	0.1667	0.8333
26	0.75	0.25	0.76	0.24	0.2857	0.7143
27	0.8125	0.1875	0.7917	0.2083	0.125	0.875
28	0.75	0.25	0.7692	0.2308	0.3333	0.6667
29	0.625	0.375	0.625	0.375	0.375	0.625
30	0.7188	0.2813	0.65	0.35	0.1667	0.8333
31	0.7188	0.2813	0.6522	0.3478	0.1111	0.8889
32	0.5313	0.4688	0.5652	0.4348	0.5556	0.4444
33	0.5	0.5	0.4706	0.5294	0.4667	0.5333
34	0.625	0.375	0.625	0.375	0.375	0.625
35	0.6875	0.3125	0.7	0.3	0.3333	0.6667
36	0.5938	0.4063	0.6364	0.3636	0.5	0.5
37	0.7188	0.2813	0.8421	0.1579	0.4615	0.5385
38	0.5938	0.4063	0.6522	0.3478	0.5556	0.4444
39	0.5625	0.4375	0.5789	0.4211	0.4615	0.5385
40	0.5	0.5	0.5	0.5	0.5	0.5
41	0.4375	0.5625	0.4375	0.5625	0.5625	0.4375
42	0.4063	0.5938	0.5714	0.4286	0.7222	0.2778
43	0.125	0.875	0.0769	0.9231	0.8421	0.1579
44	0.0625	0.9375	0.25	0.75	0.9643	0.0357
45	0.0625	0.9375	0	1	0.9333	0.0667
46	0.0625	0.9375	0	1	0.9333	0.0667
47	0	1	0	1	1	0
48	0.0313	0.9688	0	0	0.9688	0.0313
49	0	1	0	1	1	0
50	0.0313	0.9688	0	0	0.9688	0.0313
51	0	1	0	1	1	0
52	0.0313	0.9688	0	0	0.9688	0.0313

(Markov chain probability) Limit = 50						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	1	1	0
2	0.0313	0.9688	0	0	0.9688	0.0313
3	0	1	0	1	1	0
4	0	1	0	0	1	0
5	0	1	0	0	1	0
6	0	1	0	0	1	0
7	0	1	0	0	1	0
8	0.0625	0.9375	0	0	0.9375	0.0625
9	0	1	0	1	1	0
10	0	1	0	0	1	0
11	0.0313	0.9688	0	0	0.9688	0.0313
12	0.0938	0.9063	0	1	0.9032	0.0968
13	0.0938	0.9063	0	1	0.8966	0.1034
14	0.1563	0.8438	0	1	0.8276	0.1724
15	0.25	0.75	0.4	0.6	0.7778	0.2222
16	0.3438	0.6563	0.5	0.5	0.7083	0.2917
17	0.2188	0.7813	0.2727	0.7273	0.8095	0.1905
18	0.5	0.5	0.5714	0.4286	0.52	0.48
19	0.5625	0.4375	0.5625	0.4375	0.4375	0.5625
20	0.5	0.5	0.6667	0.3333	0.7143	0.2857
21	0.7188	0.2813	0.875	0.125	0.4375	0.5625
22	0.5938	0.4063	0.6957	0.3043	0.6667	0.3333
23	0.625	0.375	0.6316	0.3684	0.3846	0.6154
24	0.625	0.375	0.7	0.3	0.5	0.5
25	0.625	0.375	0.6	0.4	0.3333	0.6667
26	0.6563	0.3438	0.75	0.25	0.5	0.5
27	0.8125	0.1875	0.7619	0.2381	0.0909	0.9091
28	0.6875	0.3125	0.7308	0.2692	0.5	0.5
29	0.5313	0.4688	0.5455	0.4545	0.5	0.5
30	0.7188	0.2813	0.6471	0.3529	0.2	0.8
31	0.6875	0.3125	0.6522	0.3478	0.2222	0.7778
32	0.4688	0.5313	0.5	0.5	0.6	0.4
33	0.4375	0.5625	0.4667	0.5333	0.5882	0.4118

Continued

Continued

(Markov chain probability) Limit = 50						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
34	0.5	0.5	0.4286	0.5714	0.4444	0.5556
35	0.6875	0.3125	0.6875	0.3125	0.3125	0.6875
36	0.5625	0.4375	0.5909	0.4091	0.5	0.5
37	0.6875	0.3125	0.7778	0.2222	0.4286	0.5714
38	0.5625	0.4375	0.6818	0.3182	0.7	0.3
39	0.4688	0.5313	0.3889	0.6111	0.4286	0.5714
40	0.4375	0.5625	0.4667	0.5333	0.5882	0.4118
41	0.4063	0.5938	0.4286	0.5714	0.6111	0.3889
42	0.3438	0.6563	0.4615	0.5385	0.7368	0.2632
43	0.125	0.875	0.0909	0.9091	0.8571	0.1429
44	0.0625	0.9375	0.25	0.75	0.9643	0.0357
45	0.0625	0.9375	0	1	0.9333	0.0667
46	0.0625	0.9375	0	1	0.9333	0.0667
47	0	1	0	1	1	0
48	0.0313	0.9688	0	0	0.9688	0.0313
49	0	1	0	1	1	0
50	0.0313	0.9688	0	0	0.9688	0.0313
51	0	1	0	1	1	0
52	0.0313	0.9688	0	0	0.9688	0.0313

Wet and dry probability - Dinajpur

Initial and conditional probabilities of rainfall						
(Markov chain probability) Limit = 10						
	Initial probabilities			Conditional probabilities		
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	0	1	0
2	0.0357	0.9643	0	0	0.9643	0.0357
3	0	1	0	1	1	0
4	0.0714	0.9286	0	0	0.9286	0.0714
5	0	1	0	1	1	0
6	0.0357	0.9643	0	0	0.9643	0.0357
7	0	1	0	1	1	0
8	0	1	0	0	1	0
9	0.0357	0.9643	0	0	0.9643	0.0357
10	0	1	0	1	1	0
11	0	1	0	0	1	0
12	0.0357	0.9643	0	0	0.9643	0.0357
13	0	1	0	1	1	0
14	0.0714	0.9286	0	0	0.9286	0.0714
15	0.0714	0.9286	0.5	0.5	0.9615	0.0385
16	0.0357	0.9643	0.5	0.5	1	0
17	0.0357	0.9643	0	1	0.963	0.037
18	0.0714	0.9286	1	0	0.963	0.037
19	0.0714	0.9286	0.5	0.5	0.9615	0.0385
20	0.1071	0.8929	1	0	0.9615	0.0385
21	0.1071	0.8929	1	0	1	0
22	0.0714	0.9286	0.6667	0.3333	1	0
23	0.1071	0.8929	1	0	0.9615	0.0385
24	0.0714	0.9286	0.6667	0.3333	1	0
25	0.0714	0.9286	1	0	1	0
26	0.1071	0.8929	1	0	0.9615	0.0385
27	0.1071	0.8929	1	0	1	0
28	0.1071	0.8929	1	0	1	0
29	0.1071	0.8929	1	0	1	0
30	0.1071	0.8929	1	0	1	0

Continued

Continued

(Markov chain probability) Limit = 10						
	Initial probabilities		Conditional probabilities			
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
31	0.1071	0.8929	1	0	1	0
32	0.1071	0.8929	1	0	1	0
33	0.1071	0.8929	1	0	1	0
34	0.1071	0.8929	1	0	1	0
35	0.1071	0.8929	1	0	1	0
36	0.1071	0.8929	1	0	1	0
37	0.0357	0.9643	0.3333	0.6667	1	0
38	0.1071	0.8929	1	0	0.9259	0.0741
39	0.1071	0.8929	1	0	1	0
40	0.0357	0.9643	0.3333	0.6667	1	0
41	0.0357	0.9643	0	1	0.963	0.037
42	0.0357	0.9643	0	1	0.963	0.037
43	0.0357	0.9643	1	0	1	0
44	0	1	0	1	1	0
45	0	1	0	0	1	0
46	0	1	0	0	1	0
47	0	1	0	0	1	0
48	0	1	0	0	1	0
49	0	1	0	0	1	0
50	0.0357	0.9643	0	0	0.9643	0.0357
51	0	1	0	1	1	0
52	0	1	0	0	1	0

(Markov chain probability) Limit = 20						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	0	1	0
2	0	1	0	0	1	0
3	0	1	0	0	1	0
4	0.0357	0.9643	0	0	0.9643	0.0357
5	0	1	0	1	1	0
6	0.0357	0.9643	0	0	0.9643	0.0357
7	0	1	0	1	1	0
8	0	1	0	0	1	0
9	0	1	0	0	1	0
10	0	1	0	0	1	0
11	0	1	0	0	1	0
12	0.0357	0.9643	0	0	0.9643	0.0357
13	0	1	0	1	1	0
14	0.0357	0.9643	0	0	0.9643	0.0357
15	0.0357	0.9643	0	1	0.963	0.037
16	0.0357	0.9643	0	1	0.963	0.037
17	0.0357	0.9643	0	1	0.963	0.037
18	0.0714	0.9286	1	0	0.963	0.037
19	0.0714	0.9286	0.5	0.5	0.9615	0.0385
20	0.1071	0.8929	1	0	0.9615	0.0385
21	0.1071	0.8929	1	0	1	0
22	0.0714	0.9286	0.6667	0.3333	1	0
23	0.1071	0.8929	1	0	0.9615	0.0385
24	0.0714	0.9286	0.6667	0.3333	1	0
25	0.0714	0.9286	1	0	1	0
26	0.1071	0.8929	1	0	0.9615	0.0385
27	0.1071	0.8929	1	0	1	0
28	0.1071	0.8929	1	0	1	0
29	0.1071	0.8929	1	0	1	0
30	0.0714	0.9286	0.6667	0.3333	1	0
31	0.0714	0.9286	1	0	1	0
32	0.1071	0.8929	1	0	0.9615	0.0385
33	0.1071	0.8929	1	0	1	0

Continued

Continued

(Markov chain probability) Limit = 20						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
34	0.1071	0.8929	1	0	1	0
35	0.1071	0.8929	1	0	1	0
36	0.0714	0.9286	0.6667	0.3333	1	0
37	0.0357	0.9643	0.5	0.5	1	0
38	0.1071	0.8929	1	0	0.9259	0.0741
39	0.1071	0.8929	1	0	1	0
40	0.0357	0.9643	0.3333	0.6667	1	0
41	0.0357	0.9643	0	1	0.963	0.037
42	0.0357	0.9643	0	1	0.963	0.037
43	0.0357	0.9643	1	0	1	0
44	0	1	0	1	1	0
45	0	1	0	0	1	0
46	0	1	0	0	1	0
47	0	1	0	0	1	0
48	0	1	0	0	1	0
49	0	1	0	0	1	0
50	0.0357	0.9643	0	0	0.9643	0.0357
51	0	1	0	1	1	0
52	0	1	0	0	1	0

(Markov chain probability) Limit = 30						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	0	1	0
2	0	1	0	0	1	0
3	0	1	0	0	1	0
4	0	1	0	0	1	0
5	0	1	0	0	1	0
6	0.0357	0.9643	0	0	0.9643	0.0357
7	0	1	0	1	1	0
8	0	1	0	0	1	0
9	0	1	0	0	1	0
10	0	1	0	0	1	0
11	0	1	0	0	1	0
12	0	1	0	0	1	0

Continued

Continued

(Markov chain probability) Limit = 30						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
13	0	1	0	0	1	0
14	0	1	0	0	1	0
15	0.0357	0.9643	0	0	0.9643	0.0357
16	0.0357	0.9643	0	1	0.963	0.037
17	0	1	0	1	1	0
18	0.0714	0.9286	0	0	0.9286	0.0714
19	0.0714	0.9286	0.5	0.5	0.9615	0.0385
20	0.1071	0.8929	1	0	0.9615	0.0385
21	0.1071	0.8929	1	0	1	0
22	0.0714	0.9286	0.6667	0.3333	1	0
23	0.0714	0.9286	0.5	0.5	0.9615	0.0385
24	0.0357	0.9643	0.5	0.5	1	0
25	0.0714	0.9286	1	0	0.963	0.037
26	0.1071	0.8929	1	0	0.9615	0.0385
27	0.0714	0.9286	0.6667	0.3333	1	0
28	0.1071	0.8929	1	0	0.9615	0.0385
29	0.1071	0.8929	1	0	1	0
30	0.0714	0.9286	0.6667	0.3333	1	0
31	0.0357	0.9643	0.5	0.5	1	0
32	0.0714	0.9286	1	0	0.963	0.037
33	0.0714	0.9286	1	0	1	0
34	0.1071	0.8929	1	0	0.9615	0.0385
35	0.1071	0.8929	1	0	1	0
36	0.0357	0.9643	0.3333	0.6667	1	0
37	0.0357	0.9643	0	1	0.963	0.037
38	0.0714	0.9286	0	1	0.9259	0.0741
39	0.1071	0.8929	1	0	0.9615	0.0385
40	0.0357	0.9643	0.3333	0.6667	1	0
41	0.0357	0.9643	0	1	0.963	0.037
42	0.0357	0.9643	0	1	0.963	0.037
43	0.0357	0.9643	1	0	1	0
44	0	1	0	1	1	0
45	0	1	0	0	1	0

Continued

Continued

(Markov chain probability) Limit = 30						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
46	0	1	0	0	1	0
47	0	1	0	0	1	0
48	0	1	0	0	1	0
49	0	1	0	0	1	0
50	0.0357	0.9643	0	0	0.9643	0.0357
51	0	1	0	1	1	0
52	0	1	0	0	1	0

(Markov chain probability) Limit = 40						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	0	1	0
2	0	1	0	0	1	0
3	0	1	0	0	1	0
4	0	1	0	0	1	0
5	0	1	0	0	1	0
6	0.0357	0.9643	0	0	0.9643	0.0357
7	0	1	0	1	1	0
8	0	1	0	0	1	0
9	0	1	0	0	1	0
10	0	1	0	0	1	0
11	0	1	0	0	1	0
12	0	1	0	0	1	0
13	0	1	0	0	1	0
14	0	1	0	0	1	0
15	0.0357	0.9643	0	0	0.9643	0.0357
16	0.0357	0.9643	0	1	0.963	0.037
17	0	1	0	1	1	0
18	0.0714	0.9286	0	0	0.9286	0.0714
19	0.0714	0.9286	0.5	0.5	0.9615	0.0385
20	0.1071	0.8929	1	0	0.9615	0.0385
21	0.1071	0.8929	1	0	1	0
22	0.0714	0.9286	0.6667	0.3333	1	0
23	0.0714	0.9286	0.5	0.5	0.9615	0.0385
24	0.0357	0.9643	0.5	0.5	1	0

Continued

Continued

(Markov chain probability) Limit = 40						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
25	0.0714	0.9286	1	0	0.963	0.037
26	0.0357	0.9643	0	1	0.9615	0.0385
27	0.0714	0.9286	1	0	0.963	0.037
28	0.1071	0.8929	1	0	0.9615	0.0385
29	0.1071	0.8929	1	0	1	0
30	0.0714	0.9286	0.6667	0.3333	1	0
31	0.0357	0.9643	0.5	0.5	1	0
32	0.0714	0.9286	1	0	0.963	0.037
33	0.0714	0.9286	1	0	1	0
34	0.1071	0.8929	1	0	0.9615	0.0385
35	0.1071	0.8929	1	0	1	0
36	0.0357	0.9643	0.3333	0.6667	1	0
37	0.0357	0.9643	0	1	0.963	0.037
38	0.0357	0.9643	0	1	0.963	0.037
39	0.0714	0.9286	0	1	0.9259	0.0741
40	0.0357	0.9643	0	1	0.9615	0.0385
41	0	1	0	1	1	0
42	0.0357	0.9643	0	0	0.9643	0.0357
43	0.0357	0.9643	1	0	1	0
44	0	1	0	1	1	0
45	0	1	0	0	1	0
46	0	1	0	0	1	0
47	0	1	0	0	1	0
48	0	1	0	0	1	0
49	0	1	0	0	1	0
50	0.0357	0.9643	0	0	0.9643	0.0357
51	0	1	0	1	1	0
52	0	1	0	0	1	0

(Markov chain probability) Limit = 50						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	0	1	0
2	0	1	0	0	1	0
3	0	1	0	0	1	0
4	0	1	0	0	1	0
5	0	1	0	0	1	0
6	0	1	0	0	1	0
7	0	1	0	0	1	0
8	0	1	0	0	1	0
9	0	1	0	0	1	0
10	0	1	0	0	1	0
11	0	1	0	0	1	0
12	0	1	0	0	1	0
13	0	1	0	0	1	0
14	0	1	0	0	1	0
15	0	1	0	0	1	0
16	0.0357	0.9643	0	0	0.9643	0.0357
17	0	1	0	1	1	0
18	0.0714	0.9286	0	0	0.9286	0.0714
19	0.0714	0.9286	0.5	0.5	0.9615	0.0385
20	0.0714	0.9286	0.5	0.5	0.9615	0.0385
21	0.0714	0.9286	0.5	0.5	0.9615	0.0385
22	0.0714	0.9286	0.5	0.5	0.9615	0.0385
23	0.0714	0.9286	0.5	0.5	0.9615	0.0385
24	0.0357	0.9643	0.5	0.5	1	0
25	0.0357	0.9643	0	1	0.963	0.037
26	0.0357	0.9643	0	1	0.963	0.037
27	0.0714	0.9286	1	0	0.963	0.037
28	0.1071	0.8929	1	0	0.9615	0.0385
29	0.1071	0.8929	1	0	1	0
30	0.0357	0.9643	0.3333	0.6667	1	0
31	0.0357	0.9643	0	1	0.963	0.037
32	0.0714	0.9286	1	0	0.963	0.037
33	0.0357	0.9643	0.5	0.5	1	0

Continued

Continued

(Markov chain probability) Limit = 50						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
34	0.1071	0.8929	1	0	0.9259	0.0741
35	0.0714	0.9286	0.6667	0.3333	1	0
36	0.0357	0.9643	0	1	0.9615	0.0385
37	0.0357	0.9643	0	1	0.963	0.037
38	0.0357	0.9643	0	1	0.963	0.037
39	0.0714	0.9286	0	1	0.9259	0.0741
40	0.0357	0.9643	0	1	0.9615	0.0385
41	0	1	0	1	1	0
42	0.0357	0.9643	0	0	0.9643	0.0357
43	0.0357	0.9643	1	0	1	0
44	0	1	0	1	1	0
45	0	1	0	0	1	0
46	0	1	0	0	1	0
47	0	1	0	0	1	0
48	0	1	0	0	1	0
49	0	1	0	0	1	0
50	0	1	0	0	1	0
51	0	1	0	0	1	0
52	0	1	0	0	1	0

Wet and dry probability - Faridpur

Initial and conditional probabilities of rainfall						
(Markov chain probability) Limit = 10						
	Initial probabilities			Conditional probabilities		
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0.0278	0.9722	0	1	0.9706	0.0294
2	0	1	0	1	1	0
3	0.0541	0.9459	0	0	0.9459	0.0541
4	0.0811	0.9189	0.5	0.5	0.9429	0.0571
5	0.1622	0.8378	0.3333	0.6667	0.8529	0.1471
6	0.2162	0.7838	0.5	0.5	0.8387	0.1613
7	0.1351	0.8649	0.25	0.75	0.8966	0.1034
8	0.2432	0.7568	0.2	0.8	0.75	0.25
9	0.2432	0.7568	0.3333	0.6667	0.7857	0.2143
10	0.1892	0.8108	0.3333	0.6667	0.8571	0.1429
11	0.2432	0.7568	0.2857	0.7143	0.7667	0.2333
12	0.3243	0.6757	0.5556	0.4444	0.75	0.25
13	0.4595	0.5405	0.5833	0.4167	0.6	0.4
14	0.4595	0.5405	0.6471	0.3529	0.7	0.3
15	0.5405	0.4595	0.4706	0.5294	0.4	0.6
16	0.5676	0.4324	0.55	0.45	0.4118	0.5882
17	0.7297	0.2703	0.7143	0.2857	0.25	0.75
18	0.7297	0.2703	0.7037	0.2963	0.2	0.8
19	0.7027	0.2973	0.6667	0.3333	0.2	0.8
20	0.8108	0.1892	0.8077	0.1923	0.1818	0.8182
21	0.8108	0.1892	0.8	0.2	0.1429	0.8571
22	0.7027	0.2973	0.7333	0.2667	0.4286	0.5714
23	0.8649	0.1351	0.9231	0.0769	0.2727	0.7273
24	0.973	0.027	1	0	0.2	0.8
25	0.9189	0.0811	0.9167	0.0833	0	1
26	0.8919	0.1081	0.9118	0.0882	0.3333	0.6667
27	0.9459	0.0541	0.9394	0.0606	0	1
28	1	0	1	0	0	1
29	0.9459	0.0541	0.9459	0.0541	0	0

Continued

Continued

(Markov chain probability) Limit = 10						
	Initial probabilities			Conditional probabilities		
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
30	1	0	1	0	0	1
31	0.973	0.027	0.973	0.027	0	0
32	0.8108	0.1892	0.8333	0.1667	1	0
33	0.973	0.027	0.9667	0.0333	0	1
34	0.9189	0.0811	0.9167	0.0833	0	1
35	0.8378	0.1622	0.8235	0.1765	0	1
36	0.8919	0.1081	0.9032	0.0968	0.1667	0.8333
37	0.973	0.027	0.9697	0.0303	0	1
38	0.8108	0.1892	0.8056	0.1944	0	1
39	0.8919	0.1081	0.8667	0.1333	0	1
40	0.8108	0.1892	0.8182	0.1818	0.25	0.75
41	0.7027	0.2973	0.7	0.3	0.2857	0.7143
42	0.7027	0.2973	0.7308	0.2692	0.3636	0.6364
43	0.3514	0.6486	0.3077	0.6923	0.5455	0.4545
44	0.1351	0.8649	0.1538	0.8462	0.875	0.125
45	0.1892	0.8108	0	1	0.7813	0.2188
46	0.2162	0.7838	0.5714	0.4286	0.8667	0.1333
47	0.0811	0.9189	0	1	0.8966	0.1034
48	0.0541	0.9459	0	1	0.9412	0.0588
49	0.027	0.973	0	1	0.9714	0.0286
50	0.1081	0.8919	1	0	0.9167	0.0833
51	0.027	0.973	0	1	0.9697	0.0303
52	0.0541	0.9459	0	1	0.9444	0.0556

(Markov chain probability) Limit = 20						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0.0278	0.9722	0	1	0.9714	0.0286
2	0	1	0	1	1	0
3	0	1	0	0	1	0
4	0.0541	0.9459	0	0	0.9459	0.0541
5	0.1081	0.8919	0	1	0.8857	0.1143
6	0.1622	0.8378	0.25	0.75	0.8485	0.1515
7	0.1081	0.8919	0.3333	0.6667	0.9355	0.0645
8	0.0811	0.9189	0	1	0.9091	0.0909
9	0.0811	0.9189	0	1	0.9118	0.0882
10	0.1351	0.8649	0.3333	0.6667	0.8824	0.1176
11	0.1622	0.8378	0.2	0.8	0.8438	0.1563
12	0.2703	0.7297	0.5	0.5	0.7742	0.2258
13	0.2973	0.7027	0.5	0.5	0.7778	0.2222
14	0.2973	0.7027	0.4545	0.5455	0.7692	0.2308
15	0.4865	0.5135	0.4545	0.5455	0.5	0.5
16	0.4595	0.5405	0.4444	0.5556	0.5263	0.4737
17	0.6486	0.3514	0.7059	0.2941	0.4	0.6
18	0.6216	0.3784	0.6667	0.3333	0.4615	0.5385
19	0.6216	0.3784	0.5652	0.4348	0.2857	0.7143
20	0.7568	0.2432	0.7826	0.2174	0.2857	0.7143
21	0.7838	0.2162	0.7857	0.2143	0.2222	0.7778
22	0.6486	0.3514	0.6552	0.3448	0.375	0.625
23	0.7838	0.2162	0.8333	0.1667	0.3077	0.6923
24	0.8649	0.1351	0.8621	0.1379	0.125	0.875
25	0.8649	0.1351	0.8438	0.1563	0	1
26	0.7838	0.2162	0.7813	0.2188	0.2	0.8
27	0.8919	0.1081	0.8966	0.1034	0.125	0.875
28	0.9189	0.0811	0.9091	0.0909	0	1
29	0.7568	0.2432	0.7647	0.2353	0.3333	0.6667
30	0.8919	0.1081	0.8929	0.1071	0.1111	0.8889
31	0.9459	0.0541	0.9394	0.0606	0	1
32	0.7568	0.2432	0.7714	0.2286	0.5	0.5
33	0.8649	0.1351	0.8929	0.1071	0.2222	0.7778

Continued

Continued

(Markov chain probability) Limit = 20						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
34	0.8378	0.1622	0.8125	0.1875	0	1
35	0.8108	0.1892	0.8065	0.1935	0.1667	0.8333
36	0.8108	0.1892	0.8	0.2	0.1429	0.8571
37	0.8108	0.1892	0.8	0.2	0.1429	0.8571
38	0.6757	0.3243	0.7333	0.2667	0.5714	0.4286
39	0.7838	0.2162	0.72	0.28	0.0833	0.9167
40	0.6486	0.3514	0.6552	0.3448	0.375	0.625
41	0.5135	0.4865	0.5	0.5	0.4615	0.5385
42	0.6216	0.3784	0.6842	0.3158	0.4444	0.5556
43	0.2973	0.7027	0.2609	0.7391	0.6429	0.3571
44	0.1081	0.8919	0.1818	0.8182	0.9231	0.0769
45	0.1081	0.8919	0	1	0.8788	0.1212
46	0.1622	0.8378	0.25	0.75	0.8485	0.1515
47	0.0541	0.9459	0	1	0.9355	0.0645
48	0.0541	0.9459	0	1	0.9429	0.0571
49	0	1	0	1	1	0
50	0.0811	0.9189	0	0	0.9189	0.0811
51	0.027	0.973	0	1	0.9706	0.0294
52	0.027	0.973	0	1	0.9722	0.0278
(Markov chain probability) Limit = 30						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	1	1	0
2	0	1	0	0	1	0
3	0	1	0	0	1	0
4	0.027	0.973	0	0	0.973	0.027
5	0.0811	0.9189	0	1	0.9167	0.0833
6	0.1351	0.8649	0.3333	0.6667	0.8824	0.1176
7	0.0541	0.9459	0	1	0.9375	0.0625
8	0.0811	0.9189	0	1	0.9143	0.0857
9	0.0541	0.9459	0	1	0.9412	0.0588
10	0.0541	0.9459	0	1	0.9429	0.0571
11	0.0811	0.9189	0	1	0.9143	0.0857
12	0.1892	0.8108	0.6667	0.3333	0.8529	0.1471

Continued

Continued

(Markov chain probability) Limit = 30						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
13	0.2703	0.7297	0.5714	0.4286	0.8	0.2
14	0.2162	0.7838	0.3	0.7	0.8148	0.1852
15	0.3784	0.6216	0.375	0.625	0.6207	0.3793
16	0.3514	0.6486	0.2143	0.7857	0.5652	0.4348
17	0.5135	0.4865	0.5385	0.4615	0.5	0.5
18	0.5405	0.4595	0.6316	0.3684	0.5556	0.4444
19	0.4865	0.5135	0.45	0.55	0.4706	0.5294
20	0.6757	0.3243	0.7222	0.2778	0.3684	0.6316
21	0.7027	0.2973	0.72	0.28	0.3333	0.6667
22	0.5135	0.4865	0.5769	0.4231	0.6364	0.3636
23	0.7297	0.2703	0.7895	0.2105	0.3333	0.6667
24	0.7838	0.2162	0.7407	0.2593	0.1	0.9
25	0.8108	0.1892	0.7931	0.2069	0.125	0.875
26	0.7027	0.2973	0.7	0.3	0.2857	0.7143
27	0.7838	0.2162	0.8077	0.1923	0.2727	0.7273
28	0.8108	0.1892	0.7931	0.2069	0.125	0.875
29	0.6757	0.3243	0.6667	0.3333	0.2857	0.7143
30	0.8108	0.1892	0.8	0.2	0.1667	0.8333
31	0.8378	0.1622	0.9	0.1	0.4286	0.5714
32	0.6757	0.3243	0.6774	0.3226	0.3333	0.6667
33	0.6486	0.3514	0.72	0.28	0.5	0.5
34	0.6486	0.3514	0.5833	0.4167	0.2308	0.7692
35	0.6757	0.3243	0.6667	0.3333	0.3077	0.6923
36	0.6757	0.3243	0.72	0.28	0.4167	0.5833
37	0.7297	0.2703	0.72	0.28	0.25	0.75
38	0.6486	0.3514	0.7407	0.2593	0.6	0.4
39	0.7027	0.2973	0.6667	0.3333	0.2308	0.7692
40	0.5135	0.4865	0.5	0.5	0.4545	0.5455
41	0.4324	0.5676	0.3684	0.6316	0.5	0.5
42	0.4595	0.5405	0.375	0.625	0.4762	0.5238
43	0.2162	0.7838	0.1176	0.8824	0.7	0.3
44	0.0811	0.9189	0.25	0.75	0.9655	0.0345

Continued

Continued

(Markov chain probability) Limit = 30						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
45	0.1081	0.8919	0	1	0.8824	0.1176
46	0.1351	0.8649	0.25	0.75	0.8788	0.1212
47	0.0541	0.9459	0	1	0.9375	0.0625
48	0.0541	0.9459	0	1	0.9429	0.0571
49	0	1	0	1	1	0
50	0.027	0.973	0	0	0.973	0.027
51	0	1	0	1	1	0
52	0.027	0.973	0	0	0.973	0.027

(Markov chain probability) Limit = 40						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	1	1	0
2	0	1	0	0	1	0
3	0	1	0	0	1	0
4	0	1	0	0	1	0
5	0.027	0.973	0	0	0.973	0.027
6	0.0811	0.9189	0	1	0.9167	0.0833
7	0.0541	0.9459	0	1	0.9412	0.0588
8	0.0541	0.9459	0	1	0.9429	0.0571
9	0	1	0	1	1	0
10	0.027	0.973	0	0	0.973	0.027
11	0.0541	0.9459	0	1	0.9444	0.0556
12	0.1081	0.8919	0	1	0.8857	0.1143
13	0.2162	0.7838	0.5	0.5	0.8182	0.1818
14	0.1622	0.8378	0.25	0.75	0.8621	0.1379
15	0.1892	0.8108	0.3333	0.6667	0.8387	0.1613
16	0.2973	0.7027	0.2857	0.7143	0.7	0.3
17	0.4595	0.5405	0.4545	0.5455	0.5385	0.4615
18	0.4865	0.5135	0.5294	0.4706	0.55	0.45
19	0.3514	0.6486	0.3333	0.6667	0.6316	0.3684
20	0.5946	0.4054	0.5385	0.4615	0.375	0.625
21	0.6216	0.3784	0.6818	0.3182	0.4667	0.5333
22	0.4865	0.5135	0.5652	0.4348	0.6429	0.3571

Continued

Continued

(Markov chain probability) Limit = 40						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
23	0.6486	0.3514	0.6111	0.3889	0.3158	0.6842
24	0.5676	0.4324	0.5833	0.4167	0.4615	0.5385
25	0.7027	0.2973	0.6667	0.3333	0.25	0.75
26	0.6757	0.3243	0.6538	0.3462	0.2727	0.7273
27	0.7568	0.2432	0.76	0.24	0.25	0.75
28	0.7297	0.2703	0.75	0.25	0.3333	0.6667
29	0.5135	0.4865	0.4815	0.5185	0.4	0.6
30	0.7568	0.2432	0.6842	0.3158	0.1667	0.8333
31	0.8378	0.1622	0.9286	0.0714	0.4444	0.5556
32	0.5946	0.4054	0.5806	0.4194	0.3333	0.6667
33	0.5676	0.4324	0.5455	0.4545	0.4	0.6
34	0.5676	0.4324	0.4762	0.5238	0.3125	0.6875
35	0.4865	0.5135	0.381	0.619	0.375	0.625
36	0.6216	0.3784	0.6111	0.3889	0.3684	0.6316
37	0.5676	0.4324	0.5217	0.4783	0.3571	0.6429
38	0.5135	0.4865	0.5238	0.4762	0.5	0.5
39	0.5946	0.4054	0.4737	0.5263	0.2778	0.7222
40	0.3514	0.6486	0.4091	0.5909	0.7333	0.2667
41	0.4054	0.5946	0.4615	0.5385	0.625	0.375
42	0.3514	0.6486	0.2	0.8	0.5455	0.4545
43	0.1351	0.8649	0.1538	0.8462	0.875	0.125
44	0.0811	0.9189	0.2	0.8	0.9375	0.0625
45	0.1081	0.8919	0	1	0.8824	0.1176
46	0.1081	0.8919	0.25	0.75	0.9091	0.0909
47	0.027	0.973	0	1	0.9697	0.0303
48	0.0541	0.9459	0	1	0.9444	0.0556
49	0	1	0	1	1	0
50	0.027	0.973	0	0	0.973	0.027
51	0	1	0	1	1	0
52	0.027	0.973	0	0	0.973	0.027

(Markov chain probability) Limit = 50						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	1	1	0
2	0	1	0	0	1	0
3	0	1	0	0	1	0
4	0	1	0	0	1	0
5	0	1	0	0	1	0
6	0.0541	0.9459	0	0	0.9459	0.0541
7	0.0541	0.9459	0	1	0.9429	0.0571
8	0.027	0.973	0	1	0.9714	0.0286
9	0	1	0	1	1	0
10	0.027	0.973	0	0	0.973	0.027
11	0.0541	0.9459	0	1	0.9444	0.0556
12	0.0811	0.9189	0	1	0.9143	0.0857
13	0.1351	0.8649	0.6667	0.3333	0.9118	0.0882
14	0.1351	0.8649	0.4	0.6	0.9063	0.0938
15	0.1081	0.8919	0.4	0.6	0.9375	0.0625
16	0.2703	0.7297	0.5	0.5	0.7576	0.2424
17	0.4324	0.5676	0.4	0.6	0.5556	0.4444
18	0.3514	0.6486	0.375	0.625	0.6667	0.3333
19	0.2973	0.7027	0.3077	0.6923	0.7083	0.2917
20	0.4595	0.5405	0.3636	0.6364	0.5	0.5
21	0.5405	0.4595	0.5294	0.4706	0.45	0.55
22	0.3784	0.6216	0.4	0.6	0.6471	0.3529
23	0.5946	0.4054	0.5714	0.4286	0.3913	0.6087
24	0.5135	0.4865	0.5455	0.4545	0.5333	0.4667
25	0.6757	0.3243	0.6316	0.3684	0.2778	0.7222
26	0.6216	0.3784	0.6	0.4	0.3333	0.6667
27	0.6486	0.3514	0.6957	0.3043	0.4286	0.5714
28	0.5946	0.4054	0.6667	0.3333	0.5385	0.4615
29	0.5135	0.4865	0.4091	0.5909	0.3333	0.6667
30	0.6757	0.3243	0.6316	0.3684	0.2778	0.7222
31	0.5135	0.4865	0.52	0.48	0.5	0.5
32	0.4054	0.5946	0.3158	0.6842	0.5	0.5

Continued

Continued

(Markov chain probability) Limit = 50						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
33	0.5405	0.4595	0.4667	0.5333	0.4091	0.5909
34	0.4324	0.5676	0.4	0.6	0.5294	0.4706
35	0.3514	0.6486	0.25	0.75	0.5714	0.4286
36	0.5405	0.4595	0.5385	0.4615	0.4583	0.5417
37	0.3514	0.6486	0.35	0.65	0.6471	0.3529
38	0.4054	0.5946	0.4615	0.5385	0.625	0.375
39	0.4324	0.5676	0.3333	0.6667	0.5	0.5
40	0.2703	0.7297	0.3125	0.6875	0.7619	0.2381
41	0.3243	0.6757	0.4	0.6	0.7037	0.2963
42	0.2703	0.7297	0.1667	0.8333	0.68	0.32
43	0.1351	0.8649	0.2	0.8	0.8889	0.1111
44	0.0541	0.9459	0.2	0.8	0.9688	0.0313
45	0.1081	0.8919	0	1	0.8857	0.1143
46	0.1081	0.8919	0.25	0.75	0.9091	0.0909
47	0.027	0.973	0	1	0.9697	0.0303
48	0.0541	0.9459	0	1	0.9444	0.0556
49	0	1	0	1	1	0
50	0.027	0.973	0	0	0.973	0.027
51	0	1	0	1	1	0
52	0.027	0.973	0	0	0.973	0.027

Wet and dry probability - Madaripur

Initial and conditional probabilities of rainfall						
(Markov chain probability) Limit = 10						
	Initial probabilities			Conditional probabilities		
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0.037	0.963	0	1	0.9615	0.0385
2	0	1	0	1	1	0
3	0.0714	0.9286	0	0	0.9286	0.0714
4	0.1071	0.8929	0.5	0.5	0.9231	0.0769
5	0.0714	0.9286	0	1	0.92	0.08
6	0.1786	0.8214	1	0	0.8846	0.1154
7	0.2143	0.7857	0.4	0.6	0.8261	0.1739
8	0.2857	0.7143	0.6667	0.3333	0.8182	0.1818
9	0.2143	0.7857	0.375	0.625	0.85	0.15
10	0.1429	0.8571	0.3333	0.6667	0.9091	0.0909
11	0.25	0.75	0.5	0.5	0.7917	0.2083
12	0.3571	0.6429	0.4286	0.5714	0.6667	0.3333
13	0.4286	0.5714	0.7	0.3	0.7222	0.2778
14	0.3929	0.6071	0.5	0.5	0.6875	0.3125
15	0.4286	0.5714	0.5455	0.4545	0.6471	0.3529
16	0.4286	0.5714	0.4167	0.5833	0.5625	0.4375
17	0.6429	0.3571	0.6667	0.3333	0.375	0.625
18	0.6786	0.3214	0.7222	0.2778	0.4	0.6
19	0.6071	0.3929	0.5789	0.4211	0.3333	0.6667
20	0.7143	0.2857	0.8235	0.1765	0.4545	0.5455
21	0.8214	0.1786	0.85	0.15	0.25	0.75
22	0.6786	0.3214	0.7826	0.2174	0.8	0.2
23	0.8571	0.1429	0.9474	0.0526	0.3333	0.6667
24	0.8571	0.1429	0.9167	0.0833	0.5	0.5
25	0.9286	0.0714	1	0	0.5	0.5
26	0.8929	0.1071	0.9615	0.0385	1	0
27	0.9286	0.0714	1	0	0.6667	0.3333
28	0.8929	0.1071	0.9615	0.0385	1	0
29	0.8929	0.1071	0.96	0.04	0.6667	0.3333

Continued

Continued

(Markov chain probability) Limit = 10						
	Initial probabilities			Conditional probabilities		
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
30	0.9286	0.0714	1	0	0.6667	0.3333
31	0.9286	0.0714	1	0	1	0
32	0.8571	0.1429	0.9231	0.0769	1	0
33	0.8571	0.1429	1	0	1	0
34	0.7857	0.2143	0.875	0.125	0.75	0.25
35	0.7857	0.2143	0.8636	0.1364	0.5	0.5
36	0.75	0.25	0.8636	0.1364	0.6667	0.3333
37	0.75	0.25	0.9048	0.0952	0.7143	0.2857
38	0.7857	0.2143	0.8571	0.1429	0.4286	0.5714
39	0.7857	0.2143	0.8636	0.1364	0.5	0.5
40	0.5714	0.4286	0.6364	0.3636	0.6667	0.3333
41	0.5357	0.4643	0.6875	0.3125	0.6667	0.3333
42	0.5357	0.4643	0.5333	0.4667	0.4615	0.5385
43	0.25	0.75	0.2667	0.7333	0.7692	0.2308
44	0.3214	0.6786	0.4286	0.5714	0.7143	0.2857
45	0.1429	0.8571	0.3333	0.6667	0.9474	0.0526
46	0.1429	0.8571	0	1	0.8333	0.1667
47	0.0714	0.9286	0	1	0.9167	0.0833
48	0.0357	0.9643	0	1	0.9615	0.0385
49	0	1	0	1	1	0
50	0.0714	0.9286	0	0	0.9286	0.0714
51	0.0357	0.9643	0	1	0.9615	0.0385
52	0.0357	0.9643	0	1	0.963	0.037

(Markov chain probability) Limit = 20						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	1	1	0
2	0	1	0	1	1	0
3	0	1	0	0	1	0
4	0.0714	0.9286	0	0	0.9286	0.0714
5	0.0714	0.9286	0	1	0.9231	0.0769
6	0.1071	0.8929	0.5	0.5	0.9231	0.0769
7	0.1071	0.8929	0.3333	0.6667	0.92	0.08
8	0.1786	0.8214	0.6667	0.3333	0.88	0.12
9	0.1429	0.8571	0.4	0.6	0.913	0.087
10	0.0357	0.9643	0	1	0.9583	0.0417
11	0.1786	0.8214	0	1	0.8148	0.1852
12	0.2857	0.7143	0.4	0.6	0.7391	0.2609
13	0.3571	0.6429	0.5	0.5	0.7	0.3
14	0.3571	0.6429	0.5	0.5	0.7222	0.2778
15	0.3214	0.6786	0.3	0.7	0.6667	0.3333
16	0.25	0.75	0.2222	0.7778	0.7368	0.2632
17	0.5357	0.4643	0.5714	0.4286	0.4762	0.5238
18	0.6786	0.3214	0.7333	0.2667	0.3846	0.6154
19	0.5357	0.4643	0.5263	0.4737	0.4444	0.5556
20	0.5	0.5	0.6	0.4	0.6154	0.3846
21	0.75	0.25	0.7857	0.2143	0.2857	0.7143
22	0.6429	0.3571	0.7143	0.2857	0.5714	0.4286
23	0.75	0.25	0.8889	0.1111	0.5	0.5
24	0.75	0.25	0.8095	0.1905	0.4286	0.5714
25	0.8571	0.1429	0.9048	0.0952	0.2857	0.7143
26	0.8214	0.1786	0.875	0.125	0.5	0.5
27	0.9286	0.0714	1	0	0.4	0.6
28	0.8571	0.1429	0.9231	0.0769	1	0
29	0.8214	0.1786	0.875	0.125	0.5	0.5
30	0.8571	0.1429	0.913	0.087	0.4	0.6
31	0.9286	0.0714	1	0	0.5	0.5
32	0.7857	0.2143	0.8462	0.1538	1	0

Continued

Continued

(Markov chain probability) Limit = 20						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
33	0.7143	0.2857	0.8636	0.1364	0.8333	0.1667
34	0.7143	0.2857	0.8	0.2	0.5	0.5
35	0.6786	0.3214	0.8	0.2	0.625	0.375
36	0.6786	0.3214	0.7368	0.2632	0.4444	0.5556
37	0.75	0.25	0.8947	0.1053	0.5556	0.4444
38	0.6071	0.3929	0.619	0.381	0.4286	0.5714
39	0.75	0.25	0.7647	0.2353	0.2727	0.7273
40	0.5357	0.4643	0.619	0.381	0.7143	0.2857
41	0.4286	0.5714	0.6	0.4	0.7692	0.2308
42	0.4286	0.5714	0.5	0.5	0.625	0.375
43	0.2143	0.7857	0.25	0.75	0.8125	0.1875
44	0.25	0.75	0.3333	0.6667	0.7727	0.2273
45	0.1071	0.8929	0.2857	0.7143	0.9524	0.0476
46	0.1429	0.8571	0	1	0.84	0.16
47	0.0357	0.9643	0	1	0.9583	0.0417
48	0.0357	0.9643	0	1	0.963	0.037
49	0	1	0	1	1	0
50	0.0714	0.9286	0	0	0.9286	0.0714
51	0	1	0	1	1	0
52	0.0357	0.9643	0	0	0.9643	0.0357
(Markov chain probability) Limit = 30						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	1	1	0
2	0	1	0	1	1	0
3	0	1	0	0	1	0
4	0.0357	0.9643	0	0	0.9643	0.0357
5	0	1	0	1	1	0
6	0.0357	0.9643	0	0	0.9643	0.0357
7	0	1	0	1	1	0
8	0.1071	0.8929	0	0	0.8929	0.1071
9	0.0357	0.9643	0	1	0.96	0.04
10	0.0357	0.9643	0	1	0.963	0.037
11	0.1071	0.8929	0	1	0.8889	0.1111

Continued

Continued

(Markov chain probability) Limit = 30						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
12	0.25	0.75	0.3333	0.6667	0.76	0.24
13	0.25	0.75	0.5714	0.4286	0.8571	0.1429
14	0.25	0.75	0.5714	0.4286	0.8571	0.1429
15	0.2143	0.7857	0.1429	0.8571	0.7619	0.2381
16	0.2143	0.7857	0.1667	0.8333	0.7727	0.2273
17	0.4643	0.5357	0.6667	0.3333	0.5909	0.4091
18	0.6429	0.3571	0.6923	0.3077	0.4	0.6
19	0.4643	0.5357	0.3889	0.6111	0.4	0.6
20	0.4643	0.5357	0.5385	0.4615	0.6	0.4
21	0.6429	0.3571	0.6154	0.3846	0.3333	0.6667
22	0.5357	0.4643	0.5556	0.4444	0.5	0.5
23	0.7143	0.2857	0.8667	0.1333	0.4615	0.5385
24	0.6786	0.3214	0.75	0.25	0.5	0.5
25	0.8571	0.1429	0.8947	0.1053	0.2222	0.7778
26	0.75	0.25	0.7917	0.2083	0.5	0.5
27	0.8214	0.1786	0.9048	0.0952	0.4286	0.5714
28	0.7143	0.2857	0.7826	0.2174	0.6	0.4
29	0.8214	0.1786	0.85	0.15	0.25	0.75
30	0.7857	0.2143	0.8261	0.1739	0.4	0.6
31	0.8571	0.1429	0.9091	0.0909	0.3333	0.6667
32	0.7857	0.2143	0.8333	0.1667	0.5	0.5
33	0.6071	0.3929	0.7273	0.2727	0.8333	0.1667
34	0.6786	0.3214	0.7647	0.2353	0.4545	0.5455
35	0.6071	0.3929	0.6842	0.3158	0.5556	0.4444
36	0.5357	0.4643	0.5882	0.4118	0.5455	0.4545
37	0.6429	0.3571	0.7333	0.2667	0.4615	0.5385
38	0.5714	0.4286	0.5556	0.4444	0.4	0.6
39	0.6429	0.3571	0.5625	0.4375	0.25	0.75
40	0.4286	0.5714	0.4444	0.5556	0.6	0.4
41	0.3571	0.6429	0.5	0.5	0.75	0.25
42	0.3929	0.6071	0.4	0.6	0.6111	0.3889
43	0.1786	0.8214	0.1818	0.8182	0.8235	0.1765
44	0.1071	0.8929	0.2	0.8	0.913	0.087

Continued

Continued

(Markov chain probability) Limit = 30						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
45	0.1071	0.8929	0.3333	0.6667	0.92	0.08
46	0.1071	0.8929	0	1	0.88	0.12
47	0.0357	0.9643	0	1	0.96	0.04
48	0.0357	0.9643	0	1	0.963	0.037
49	0	1	0	1	1	0
50	0	1	0	0	1	0
51	0	1	0	0	1	0
52	0.0357	0.9643	0	0	0.9643	0.0357
(Markov chain probability) Limit = 40						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	1	1	0
2	0	1	0	0	1	0
3	0	1	0	0	1	0
4	0.0357	0.9643	0	0	0.9643	0.0357
5	0	1	0	1	1	0
6	0.0357	0.9643	0	0	0.9643	0.0357
7	0	1	0	1	1	0
8	0	1	0	0	1	0
9	0.0357	0.9643	0	0	0.9643	0.0357
10	0.0357	0.9643	0	1	0.963	0.037
11	0.0714	0.9286	0	1	0.9259	0.0741
12	0.2143	0.7857	0.5	0.5	0.8077	0.1923
13	0.2143	0.7857	0.5	0.5	0.8636	0.1364
14	0.1786	0.8214	0.3333	0.6667	0.8636	0.1364
15	0.1429	0.8571	0.2	0.8	0.8696	0.1304
16	0.1786	0.8214	0	1	0.7917	0.2083
17	0.3929	0.6071	0.6	0.4	0.6522	0.3478
18	0.6071	0.3929	0.6364	0.3636	0.4118	0.5882
19	0.3571	0.6429	0.2353	0.7647	0.4545	0.5455
20	0.3929	0.6071	0.5	0.5	0.6667	0.3333
21	0.5714	0.4286	0.6364	0.3636	0.4706	0.5294
22	0.5	0.5	0.5625	0.4375	0.5833	0.4167

Continued

Continued

(Markov chain probability) Limit = 40						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
23	0.6429	0.3571	0.7143	0.2857	0.4286	0.5714
24	0.6071	0.3929	0.6667	0.3333	0.5	0.5
25	0.75	0.25	0.7647	0.2353	0.2727	0.7273
26	0.7143	0.2857	0.7619	0.2381	0.4286	0.5714
27	0.75	0.25	0.8	0.2	0.375	0.625
28	0.6429	0.3571	0.7143	0.2857	0.5714	0.4286
29	0.7143	0.2857	0.7222	0.2778	0.3	0.7
30	0.6786	0.3214	0.75	0.25	0.5	0.5
31	0.6786	0.3214	0.7895	0.2105	0.5556	0.4444
32	0.6786	0.3214	0.6842	0.3158	0.3333	0.6667
33	0.5	0.5	0.5789	0.4211	0.6667	0.3333
34	0.6071	0.3929	0.5714	0.4286	0.3571	0.6429
35	0.5	0.5	0.5294	0.4706	0.5455	0.4545
36	0.4643	0.5357	0.5714	0.4286	0.6429	0.3571
37	0.5	0.5	0.5385	0.4615	0.5333	0.4667
38	0.4286	0.5714	0.5	0.5	0.6429	0.3571
39	0.6071	0.3929	0.5	0.5	0.3125	0.6875
40	0.3929	0.6071	0.3529	0.6471	0.5455	0.4545
41	0.3571	0.6429	0.5455	0.4545	0.7647	0.2353
42	0.3214	0.6786	0.4	0.6	0.7222	0.2778
43	0.1429	0.8571	0.1111	0.8889	0.8421	0.1579
44	0.1071	0.8929	0.25	0.75	0.9167	0.0833
45	0.1071	0.8929	0.3333	0.6667	0.92	0.08
46	0.1071	0.8929	0	1	0.88	0.12
47	0.0357	0.9643	0	1	0.96	0.04
48	0.0357	0.9643	0	1	0.963	0.037
49	0	1	0	1	1	0
50	0	1	0	0	1	0
51	0	1	0	0	1	0
52	0.0357	0.9643	0	0	0.9643	0.0357

(Markov chain probability) Limit = 50						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
1	0	1	0	0	1	0
2	0	1	0	0	1	0
3	0	1	0	0	1	0
4	0	1	0	0	1	0
5	0	1	0	0	1	0
6	0	1	0	0	1	0
7	0	1	0	0	1	0
8	0	1	0	0	1	0
9	0.0357	0.9643	0	0	0.9643	0.0357
10	0.0357	0.9643	0	1	0.963	0.037
11	0.0357	0.9643	0	1	0.963	0.037
12	0.1429	0.8571	0	1	0.8519	0.1481
13	0.1786	0.8214	0.5	0.5	0.875	0.125
14	0.1071	0.8929	0.2	0.8	0.913	0.087
15	0.0714	0.9286	0	1	0.92	0.08
16	0.1429	0.8571	0	1	0.8462	0.1538
17	0.25	0.75	0	1	0.7083	0.2917
18	0.4643	0.5357	0.7143	0.2857	0.619	0.381
19	0.3214	0.6786	0.2308	0.7692	0.6	0.4
20	0.3214	0.6786	0.4444	0.5556	0.7368	0.2632
21	0.4643	0.5357	0.4444	0.5556	0.5263	0.4737
22	0.5	0.5	0.4615	0.5385	0.4667	0.5333
23	0.6071	0.3929	0.6429	0.3571	0.4286	0.5714
24	0.5357	0.4643	0.5882	0.4118	0.5455	0.4545
25	0.6786	0.3214	0.7333	0.2667	0.3846	0.6154
26	0.6071	0.3929	0.5789	0.4211	0.3333	0.6667
27	0.7143	0.2857	0.7059	0.2941	0.2727	0.7273
28	0.6071	0.3929	0.65	0.35	0.5	0.5
29	0.6071	0.3929	0.5294	0.4706	0.2727	0.7273
30	0.5357	0.4643	0.5294	0.4706	0.4545	0.5455
31	0.6071	0.3929	0.6	0.4	0.3846	0.6154
32	0.6429	0.3571	0.6471	0.3529	0.3636	0.6364

Continued

Continued

(Markov chain probability) Limit = 50						
WEEK	P(W)	P(D)	P(W/W)	P(D/W)	P(D/D)	P(W/D)
33	0.5	0.5	0.5556	0.4444	0.6	0.4
34	0.5	0.5	0.4286	0.5714	0.4286	0.5714
35	0.3214	0.6786	0.3571	0.6429	0.7143	0.2857
36	0.3929	0.6071	0.5556	0.4444	0.6842	0.3158
37	0.4643	0.5357	0.5455	0.4545	0.5882	0.4118
38	0.3571	0.6429	0.4615	0.5385	0.7333	0.2667
39	0.5357	0.4643	0.4	0.6	0.3889	0.6111
40	0.3214	0.6786	0.2667	0.7333	0.6154	0.3846
41	0.3571	0.6429	0.5556	0.4444	0.7368	0.2632
42	0.3214	0.6786	0.4	0.6	0.7222	0.2778
43	0.1429	0.8571	0.1111	0.8889	0.8421	0.1579
44	0.0714	0.9286	0.25	0.75	0.9583	0.0417
45	0.1071	0.8929	0.5	0.5	0.9231	0.0769
46	0.0714	0.9286	0	1	0.92	0.08
47	0.0357	0.9643	0	1	0.9615	0.0385
48	0.0357	0.9643	0	1	0.963	0.037
49	0	1	0	1	1	0
50	0	1	0	0	1	0
51	0	1	0	0	1	0
52	0	1	0	0	1	0

Annexure 2

Consolidated data of heavy rain in Dinajpur district (mm) – Total.

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1981	Total	17	591	10	580	4	349	1	140
1982	Total	14	469	3	177	0	0	1	109
1983	Total	12	394	5	291	5	424	2	309
1984	Total	21	674	10	591	2	176	2	204
1985	Total	15	532	6	363	3	274	3	366
1986	Total	17	612	6	356	2	168	2	290
1987	Total	18	642	5	278	9	764	5	812
1988	Total	18	662	9	529	1	98	2	414
1989	Total	15	536	4	249	0	0	5	584
1990	Total	15	512	3	182	5	411	2	279
1991	Total	11	375	7	404	2	164	3	475
1992	Total	9	325	2	133	4	351	3	484
1993	Total	21	640	6	336	3	247	3	324
1994	Total	8	269	6	345	0	0	0	0
1995	Total	10	342	4	226	2	154	6	1295
1996	Total	11	357	0	0	3	275	3	775
1997	Total	17	588	4	227	3	245	2	342
1998	Total	12	434	11	708	2	159	3	490
1999	Total	19	686	7	440	2	175	3	587
2000	Total	11	352	4	236	1	86	1	102
2001	Total	17	591	4	256	3	260	5	583
2002	Total	20	688	8	498	3	231	4	540
2003	Total	12	396	6	357	2	154	2	380
2004	Total	16	516	7	416	4	339	3	364
2005	Total	12	389	7	429	3	265	7	1304
2006	Total	7	229	7	401	0	0	0	0
2007	Total	11	393	6	338	2	172	1	105
2008	Total	19	663	5	305	2	176	0	0

Consolidated data of heavy rain in Dinajpur district (mm) – Southwest monsoon.

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1981	Southwest monsoon	7	236	9	522	3	270	1	140
1982	Southwest monsoon	5	165	1	58	0	0	0	0
1983	Southwest monsoon	5	160	3	174	3	258	0	0
1984	Southwest monsoon	13	400	3	158	1	85	1	102
1985	Southwest monsoon	5	177	2	137	0	0	1	115
1986	Southwest monsoon	6	209	3	176	0	0	2	290
1987	Southwest monsoon	8	287	3	176	1	82	2	401
1988	Southwest monsoon	10	384	4	212	1	98	1	187
1989	Southwest monsoon	5	182	3	183	0	0	4	482
1990	Southwest monsoon	6	218	2	118	3	244	1	158
1991	Southwest monsoon	3	119	3	180	1	79	1	115
1992	Southwest monsoon	1	49	1	70	3	256	2	376
1993	Southwest monsoon	12	361	2	112	2	171	2	207
1994	Southwest monsoon	3	111	2	113	0	0	0	0
1995	Southwest monsoon	5	179	2	110	1	76	4	945
1996	Southwest monsoon	4	137	0	0	2	182	1	508
1997	Southwest monsoon	10	342	2	109	1	76	1	231
1998	Southwest monsoon	4	140	8	500	0	0	0	0

Continued

Continued

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1999	Southwest monsoon	6	230	3	192	2	175	2	419
2000	Southwest monsoon	6	185	1	58	1	86	0	0
2001	Southwest monsoon	5	160	1	72	1	94	2	234
2002	Southwest monsoon	11	357	3	184	2	155	3	369
2003	Southwest monsoon	6	192	4	233	1	76	1	113
2004	Southwest monsoon	7	227	2	126	3	245	2	245
2005	Southwest monsoon	8	247	2	127	0	0	1	100
2006	Southwest monsoon	3	92	4	229	0	0	0	0
2007	Southwest monsoon	5	174	3	157	1	75	1	105
2008	Southwest monsoon	7	275	4	246	1	92	0	0

Consolidated data of heavy rain in Dinajpur district (mm) – Northeast monsoon.

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1981	Northeast monsoon	1	38	0	0	0	0	0	0
1982	Northeast monsoon	2	65	0	0	0	0	0	0
1983	Northeast monsoon	0	0	0	0	1	76	0	0
1984	Northeast monsoon	1	35	0	0	0	0	0	0
1985	Northeast monsoon	1	29	0	0	0	0	2	251
1986	Northeast monsoon	1	33	1	56	0	0	0	0
1987	Northeast monsoon	0	0	0	0	1	84	0	0
1988	Northeast monsoon	0	0	0	0	0	0	0	0
1989	Northeast monsoon	0	0	0	0	0	0	0	0
1990	Northeast monsoon	0	0	0	0	0	0	0	0
1991	Northeast monsoon	0	0	0	0	0	0	0	0
1992	Northeast monsoon	0	0	0	0	0	0	0	0
1993	Northeast monsoon	1	25	0	0	0	0	0	0
1994	Northeast monsoon	0	0	0	0	0	0	0	0
1995	Northeast monsoon	1	33	1	56	0	0	0	0
1996	Northeast monsoon	0	0	0	0	0	0	0	0
1997	Northeast monsoon	0	0	0	0	0	0	0	0
1998	Northeast monsoon	1	37	0	0	0	0	2	310
1999	Northeast monsoon	0	0	0	0	0	0	1	168
2000	Northeast monsoon	0	0	0	0	0	0	0	0

Continued

Continued

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
2001	Northeast monsoon	1	30	0	0	0	0	0	0
2002	Northeast monsoon	1	49	0	0	0	0	0	0
2003	Northeast monsoon	1	36	0	0	0	0	1	267
2004	Northeast monsoon	0	0	0	0	0	0	0	0
2005	Northeast monsoon	0	0	1	52	1	94	0	0
2006	Northeast monsoon	0	0	0	0	0	0	0	0
2007	Northeast monsoon	0	0	0	0	0	0	0	0
2008	Northeast monsoon	0	0	0	0	0	0	0	0

Consolidated data of heavy rain in Dinajpur district (mm) – Winter.

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1981	Winter	4	130	0	0	0	0	0	0
1982	Winter	3	100	2	119	0	0	1	109
1983	Winter	4	129	0	0	0	0	0	0
1984	Winter	4	145	6	374	0	0	1	102
1985	Winter	4	138	2	109	1	98	0	0
1986	Winter	6	218	1	70	1	91	0	0
1987	Winter	8	289	1	52	1	94	3	411
1988	Winter	3	97	2	128	0	0	0	0
1989	Winter	8	282	1	66	0	0	0	0
1990	Winter	6	188	1	64	2	167	1	121
1991	Winter	5	151	2	114	1	85	2	360
1992	Winter	4	148	1	63	1	95	0	0
1993	Winter	6	198	4	224	1	76	0	0
1994	Winter	2	58	2	114	0	0	0	0
1995	Winter	2	61	0	0	1	78	1	209
1996	Winter	2	55	0	0	1	93	0	0
1997	Winter	3	103	1	64	1	91	1	111
1998	Winter	3	104	1	68	1	83	1	180
1999	Winter	6	188	3	197	0	0	0	0
2000	Winter	5	167	1	58	0	0	1	102
2001	Winter	7	235	3	184	2	166	2	219
2002	Winter	5	159	3	192	0	0	0	0
2003	Winter	4	142	1	52	1	78	0	0
2004	Winter	6	204	4	231	0	0	1	119
2005	Winter	3	115	2	122	2	171	2	297
2006	Winter	1	32	2	120	0	0	0	0
2007	Winter	4	162	1	53	1	97	0	0
2008	Winter	7	241	1	59	0	0	0	0

Continued

Consolidated data of heavy rain in Dinajpur district (mm) – Summer.

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1981	Summer	5	187	1	58	1	79	0	0
1982	Summer	4	139	0	0	0	0	0	0
1983	Summer	3	105	2	117	1	90	2	309
1984	Summer	3	94	1	59	1	91	0	0
1985	Summer	5	188	2	117	2	176	0	0
1986	Summer	4	152	1	54	1	77	0	0
1987	Summer	2	66	1	50	6	504	0	0
1988	Summer	5	181	3	189	0	0	1	227
1989	Summer	2	72	0	0	0	0	1	102
1990	Summer	3	106	0	0	0	0	0	0
1991	Summer	3	105	2	110	0	0	0	0
1992	Summer	4	128	0	0	0	0	1	108
1993	Summer	2	56	0	0	0	0	1	117
1994	Summer	3	100	2	118	0	0	0	0
1995	Summer	2	69	1	60	0	0	1	141
1996	Summer	5	165	0	0	0	0	2	267
1997	Summer	4	143	1	54	1	78	0	0
1998	Summer	4	153	2	140	1	76	0	0
1999	Summer	7	268	1	51	0	0	0	0
2000	Summer	0	0	2	120	0	0	0	0
2001	Summer	4	166	0	0	0	0	1	130
2002	Summer	3	123	2	122	1	76	1	171
2003	Summer	1	26	1	72	0	0	0	0
2004	Summer	3	85	1	59	1	94	0	0
2005	Summer	1	27	2	128	0	0	4	907
2006	Summer	3	105	1	52	0	0	0	0
2007	Summer	2	57	2	128	0	0	0	0
2008	Summer	5	147	0	0	1	84	0	0

Annexure 3

Consolidated data of heavy rain in Madaripur district (mm) – Total.

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1981	Total	17	571	4	222	2	156	0	0
1982	Total	0	0	0	0	0	0	0	0
1983	Total	0	0	0	0	0	0	0	0
1984	Total	31	1098	14	812	1	78	1	125
1985	Total	13	405	9	523	6	526	4	524
1986	Total	12	407	6	360	5	440	8	1071
1987	Total	13	462	6	380	4	362	3	395
1988	Total	22	707	4	246	1	96	2	259
1989	Total	16	549	3	176	0	0	0	0
1990	Total	16	612	4	234	4	346	0	0
1991	Total	19	634	8	473	2	179	2	291
1992	Total	13	433	2	120	2	153	0	0
1993	Total	22	705	4	234	2	161	2	304
1994	Total	16	563	4	242	3	266	0	0
1995	Total	15	534	5	291	1	82	3	562
1996	Total	13	505	6	338	2	153	1	108
1997	Total	22	740	7	377	3	255	0	0
1998	Total	14	440	7	427	5	422	1	186
1999	Total	23	804	3	185	1	75	3	359
2000	Total	22	725	5	304	2	177	1	105
2001	Total	23	757	8	514	3	245	2	212
2002	Total	20	613	7	425	3	259	2	227
2003	Total	18	631	6	353	1	94	0	0
2004	Total	15	488	1	50	5	408	4	645
2005	Total	11	351	7	420	2	159	3	379
2006	Total	8	271	6	376	1	75	1	158
2007	Total	16	530	2	127	4	344	3	325
2008	Total	13	455	2	145	3	253	0	0

Consolidated data of heavy rain in Madaripur district (mm) – Southwest monsoon.

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1981	Southwest monsoon	9	321	3	172	2	156	0	0
1982	Southwest monsoon	0	0	0	0	0	0	0	0
1983	Southwest monsoon	0	0	0	0	0	0	0	0
1984	Southwest monsoon	13	445	5	274	0	0	0	0
1985	Southwest monsoon	5	130	5	290	2	171	1	137
1986	Southwest monsoon	7	243	5	295	4	364	4	562
1987	Southwest monsoon	8	319	0	0	3	265	2	267
1988	Southwest monsoon	9	263	1	53	0	0	0	0
1989	Southwest monsoon	4	133	3	176	0	0	0	0
1990	Southwest monsoon	8	328	2	120	3	262	0	0
1991	Southwest monsoon	10	335	2	100	0	0	0	0
1992	Southwest monsoon	6	216	0	0	0	0	0	0
1993	Southwest monsoon	12	381	3	174	2	161	0	0
1994	Southwest monsoon	6	197	2	103	2	190	0	0
1995	Southwest monsoon	9	342	0	0	1	82	2	319
1996	Southwest monsoon	3	108	1	50	0	0	0	0
1997	Southwest monsoon	9	300	2	101	1	96	0	0
1998	Southwest monsoon	5	162	1	58	2	168	0	0

Continued

Continued

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1999	Southwest monsoon	12	415	0	0	1	75	0	0
2000	Southwest monsoon	8	268	3	193	2	177	0	0
2001	Southwest monsoon	9	300	3	195	2	165	1	104
2002	Southwest monsoon	8	244	3	183	0	0	1	110
2003	Southwest monsoon	5	175	3	178	0	0	0	0
2004	Southwest monsoon	7	229	0	0	2	163	3	514
2005	Southwest monsoon	5	175	2	117	1	79	1	132
2006	Southwest monsoon	3	105	1	70	1	75	0	0
2007	Southwest monsoon	10	349	0	0	1	96	0	0
2008	Southwest monsoon	8	274	2	145	1	91	0	0

Consolidated data of heavy rain in Madaripur district (mm) – Northeast monsoon.

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1981	Northeast monsoon	0	0	0	0	0	0	0	0
1982	Northeast monsoon	0	0	0	0	0	0	0	0
1983	Northeast monsoon	0	0	0	0	0	0	0	0
1984	Northeast monsoon	3	110	0	0	0	0	0	0
1985	Northeast monsoon	0	0	0	0	0	0	1	135
1986	Northeast monsoon	1	35	0	0	0	0	0	0
1987	Northeast monsoon	0	0	2	132	0	0	0	0
1988	Northeast monsoon	3	98	0	0	1	96	0	0
1989	Northeast monsoon	0	0	0	0	0	0	0	0
1990	Northeast monsoon	0	0	0	0	0	0	0	0
1991	Northeast monsoon	0	0	2	128	1	89	0	0
1992	Northeast monsoon	1	42	0	0	0	0	0	0
1993	Northeast monsoon	0	0	0	0	0	0	0	0
1994	Northeast monsoon	0	0	0	0	0	0	0	0
1995	Northeast monsoon	0	0	2	130	0	0	0	0
1996	Northeast monsoon	0	0	1	62	0	0	1	108
1997	Northeast monsoon	0	0	0	0	0	0	0	0
1998	Northeast monsoon	2	58	0	0	1	77	0	0

Continued

Continued

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1999	Northeast monsoon	2	85	1	68	0	0	1	104
2000	Northeast monsoon	3	88	0	0	0	0	1	105
2001	Northeast monsoon	1	26	0	0	0	0	0	0
2002	Northeast monsoon	1	27	1	73	0	0	0	0
2003	Northeast monsoon	2	77	0	0	0	0	0	0
2004	Northeast monsoon	0	0	0	0	0	0	0	0
2005	Northeast monsoon	3	92	1	50	1	80	0	0
2006	Northeast monsoon	0	0	0	0	0	0	0	0
2007	Northeast monsoon	0	0	0	0	1	95	1	103
2008	Northeast monsoon	0	0	0	0	2	162	0	0

Consolidated data of heavy rain in Madaripur district (mm) – Winter.

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1981	Winter	7	214	1	50	0	0	0	0
1982	Winter	0	0	0	0	0	0	0	0
1983	Winter	0	0	0	0	0	0	0	0
1984	Winter	11	391	6	365	1	78	0	0
1985	Winter	5	153	0	0	4	355	1	140
1986	Winter	2	68	1	65	0	0	1	115
1987	Winter	3	80	2	128	1	97	1	128
1988	Winter	7	256	2	129	0	0	0	0
1989	Winter	7	261	0	0	0	0	0	0
1990	Winter	4	159	1	62	1	84	0	0
1991	Winter	8	272	2	118	1	90	2	291
1992	Winter	4	106	1	63	1	78	0	0
1993	Winter	7	230	1	60	0	0	0	0
1994	Winter	6	201	2	139	1	76	0	0
1995	Winter	4	130	3	161	0	0	0	0
1996	Winter	6	239	2	103	2	153	0	0
1997	Winter	6	217	4	222	2	159	0	0
1998	Winter	3	86	2	113	0	0	1	186
1999	Winter	8	271	0	0	0	0	2	255
2000	Winter	7	237	1	53	0	0	0	0
2001	Winter	11	352	3	198	1	80	1	108
2002	Winter	6	189	3	169	1	94	0	0
2003	Winter	5	186	2	109	0	0	0	0
2004	Winter	2	55	1	50	2	167	0	0
2005	Winter	1	25	3	190	0	0	1	140
2006	Winter	3	108	5	306	0	0	0	0
2007	Winter	4	122	2	127	1	77	2	222
2008	Winter	2	73	0	0	0	0	0	0

Consolidated data of heavy rain in Madaripur district (mm) – Summer.

		25 <50		50 <75		5 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1981	Summer	1	36	0	0	0	0	0	0
1982	Summer	0	0	0	0	0	0	0	0
1983	Summer	0	0	0	0	0	0	0	0
1984	Summer	4	152	3	173	0	0	1	125
1985	Summer	3	122	4	233	0	0	1	112
1986	Summer	2	61	0	0	1	76	3	394
1987	Summer	2	63	2	120	0	0	0	0
1988	Summer	3	90	1	64	0	0	2	259
1989	Summer	5	155	0	0	0	0	0	0
1990	Summer	4	125	1	52	0	0	0	0
1991	Summer	1	27	2	127	0	0	0	0
1992	Summer	2	69	1	57	1	75	0	0
1993	Summer	3	94	0	0	0	0	2	304
1994	Summer	4	165	0	0	0	0	0	0
1995	Summer	2	62	0	0	0	0	1	243
1996	Summer	4	158	2	123	0	0	0	0
1997	Summer	7	223	1	54	0	0	0	0
1998	Summer	4	134	4	256	2	177	0	0
1999	Summer	1	33	2	117	0	0	0	0
2000	Summer	4	132	1	58	0	0	0	0
2001	Summer	2	79	2	121	0	0	0	0
2002	Summer	5	153	0	0	2	165	1	117
2003	Summer	6	193	1	66	1	94	0	0
2004	Summer	6	204	0	0	1	78	1	131
2005	Summer	2	59	1	63	0	0	1	107
2006	Summer	2	58	0	0	0	0	1	158
2007	Summer	2	59	0	0	1	76	0	0
2008	Summer	3	108	0	0	0	0	0	0

Frequency of Minimum temperature (°C) – Madaripur district*.

Year	Month	<=10	<=7	<=5	<=2	<=0
1977	Total	31	3	0	0	0
1978	Total	27	0	0	0	0
1979	Total	0	0	0	0	0
1980	Total	8	0	0	0	0
1982	Total	9	0	0	0	0
1983	Total	30	0	0	0	0
1984	Total	9	0	0	0	0
1985	Total	3	0	0	0	0
1986	Total	7	0	0	0	0
1991	Total	10	0	0	0	0
1992	Total	12	0	0	0	0
1993	Total	13	1	0	0	0
1994	Total	8	0	0	0	0
1995	Total	16	0	0	0	0
1996	Total	3	0	0	0	0
1997	Total	12	0	0	0	0
1998	Total	4	0	0	0	0
1999	Total	0	0	0	0	0
2000	Total	5	0	0	0	0
2001	Total	12	0	0	0	0
2002	Total	0	0	0	0	0
2003	Total	6	0	0	0	0
2004	Total	2	0	0	0	0
2005	Total	0	0	0	0	0
2006	Total	3	0	0	0	0
2007	Total	7	0	0	0	0
2008	Total	1	0	0	0	0

*Missing years data not available.

Annexure 4

Consolidated data of heavy rain in Rajshahi district (mm) – Total.

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1974	Total	23	819	6	325	0	0	1	137
1975	Total	11	420	2	125	0	0	0	0
1976	Total	12	426	4	229	2	174	1	132
1977	Total	10	358	6	360	2	182	2	271
1978	Total	15	534	1	52	3	240	2	407
1979	Total	16	520	4	244	2	165	2	280
1980	Total	14	444	5	279	1	89	1	100
1981	Total	17	576	7	413	4	343	1	184
1982	Total	16	527	2	121	0	0	0	0
1983	Total	8	315	2	124	1	81	4	599
1984	Total	15	526	2	118	2	176	1	122
1985	Total	0	0	0	0	0	0	0	0
1986	Total	0	0	0	0	0	0	0	0
1987	Total	0	0	0	0	0	0	0	0
1988	Total	7	222	3	171	0	0	0	0
1989	Total	11	355	3	173	3	245	0	0
1990	Total	13	451	7	420	2	157	0	0
1991	Total	15	538	3	186	0	0	1	154
1992	Total	10	325	2	134	0	0	0	0
1993	Total	8	296	3	170	5	400	1	153
1994	Total	13	416	1	56	1	75	0	0
1995	Total	15	488	4	252	1	77	0	0
1996	Total	10	348	5	288	1	81	0	0
1997	Total	16	542	6	341	3	250	3	405
1998	Total	19	600	4	269	1	87	0	0
1999	Total	20	705	2	140	4	334	1	107
2000	Total	13	426	1	58	1	78	3	419
2001	Total	11	392	1	71	3	264	1	109

Continued

Continued

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
2002	Total	16	557	3	191	1	79	0	0
2003	Total	7	238	5	300	1	75	1	113
2004	Total	16	569	5	281	2	175	1	247
2005	Total	15	478	4	237	1	79	1	151
2006	Total	14	462	3	173	0	0	0	0
2007	Total	12	400	6	356	1	92	3	655
2008	Total	10	351	2	121	0	0	1	170

Consolidated data of heavy rain in Rajshahi district (mm) – Southwest monsoon.

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1974	Southwest monsoon	8	285	6	325	0	0	0	0
1975	Southwest monsoon	5	197	1	59	0	0	0	0
1976	Southwest monsoon	7	241	3	163	1	89	1	132
1977	Southwest monsoon	6	219	3	178	1	84	1	101
1978	Southwest monsoon	8	281	0	0	1	79	1	221
1979	Southwest monsoon	7	216	2	111	1	75	1	179
1980	Southwest monsoon	7	214	1	52	0	0	0	0
1981	Southwest monsoon	9	303	6	340	2	168	0	0
1982	Southwest monsoon	7	205	0	0	0	0	0	0
1983	Southwest monsoon	1	33	1	55	0	0	1	153
1984	Southwest monsoon	10	340	1	50	0	0	0	0
1985	Southwest monsoon	0	0	0	0	0	0	0	0
1986	Southwest monsoon	0	0	0	0	0	0	0	0
1987	Southwest monsoon	0	0	0	0	0	0	0	0
1988	Southwest monsoon	4	111	1	61	0	0	0	0
1989	Southwest monsoon	6	210	2	123	1	79	0	0
1990	Southwest monsoon	4	133	2	117	2	157	0	0
1991	Southwest monsoon	6	216	0	0	0	0	1	154

Continued

Continued

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1992	Southwest monsoon	6	190	2	134	0	0	0	0
1993	Southwest monsoon	4	144	1	58	2	155	1	153
1994	Southwest monsoon	6	189	1	56	0	0	0	0
1995	Southwest monsoon	6	192	2	135	1	77	0	0
1996	Southwest monsoon	4	126	1	55	1	81	0	0
1997	Southwest monsoon	4	140	3	164	2	175	1	164
1998	Southwest monsoon	6	203	1	57	0	0	0	0
1999	Southwest monsoon	7	241	0	0	0	0	1	107
2000	Southwest monsoon	4	129	0	0	0	0	2	316
2001	Southwest monsoon	8	296	0	0	1	94	0	0
2002	Southwest monsoon	7	242	0	0	1	79	0	0
2003	Southwest monsoon	2	64	0	0	1	75	1	113
2004	Southwest monsoon	8	291	2	122	1	89	0	0
2005	Southwest monsoon	7	252	1	54	0	0	0	0
2006	Southwest monsoon	7	219	0	0	0	0	0	0
2007	Southwest monsoon	4	154	1	55	1	92	1	400
2008	Southwest monsoon	5	180	0	0	0	0	0	0

Consolidated data of heavy rain in Rajshahi district (mm) – Northeast monsoon.

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1974	Northeast monsoon	3	109	0	0	0	0	0	0
1975	Northeast monsoon	0	0	0	0	0	0	0	0
1976	Northeast monsoon	1	26	0	0	0	0	0	0
1977	Northeast monsoon	0	0	1	66	0	0	0	0
1978	Northeast monsoon	0	0	0	0	0	0	0	0
1979	Northeast monsoon	2	76	0	0	0	0	0	0
1980	Northeast monsoon	0	0	0	0	0	0	1	100
1981	Northeast monsoon	0	0	1	73	0	0	0	0
1982	Northeast monsoon	2	85	0	0	0	0	0	0
1983	Northeast monsoon	0	0	1	69	0	0	1	173
1984	Northeast monsoon	1	34	0	0	0	0	0	0
1985	Northeast monsoon	0	0	0	0	0	0	0	0
1986	Northeast monsoon	0	0	0	0	0	0	0	0
1987	Northeast monsoon	0	0	0	0	0	0	0	0
1988	Northeast monsoon	0	0	0	0	0	0	0	0
1989	Northeast monsoon	1	29	0	0	0	0	0	0
1990	Northeast monsoon	0	0	0	0	0	0	0	0
1991	Northeast monsoon	2	52	1	59	0	0	0	0

Continued

Continued

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1992	Northeast monsoon	0	0	0	0	0	0	0	0
1993	Northeast monsoon	1	42	0	0	1	86	0	0
1994	Northeast monsoon	1	38	0	0	0	0	0	0
1995	Northeast monsoon	1	37	0	0	0	0	0	0
1996	Northeast monsoon	1	30	1	57	0	0	0	0
1997	Northeast monsoon	1	44	0	0	0	0	0	0
1998	Northeast monsoon	3	95	0	0	0	0	0	0
1999	Northeast monsoon	2	76	0	0	0	0	0	0
2000	Northeast monsoon	1	32	0	0	0	0	0	0
2001	Northeast monsoon	0	0	0	0	0	0	0	0
2002	Northeast monsoon	0	0	0	0	0	0	0	0
2003	Northeast monsoon	1	35	1	60	0	0	0	0
2004	Northeast monsoon	0	0	0	0	0	0	0	0
2005	Northeast monsoon	3	80	1	74	0	0	0	0
2006	Northeast monsoon	0	0	0	0	0	0	0	0
2007	Northeast monsoon	0	0	0	0	0	0	0	0
2008	Northeast monsoon	1	30	0	0	0	0	0	0

Consolidated data of heavy rain in Rajshahi district (mm) – Winter

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1974	Winter	10	356	0	0	0	0	1	137
1975	Winter	3	100	0	0	0	0	0	0
1976	Winter	3	122	1	66	1	85	0	0
1977	Winter	3	96	0	0	0	0	0	0
1978	Winter	5	196	0	0	0	0	0	0
1979	Winter	3	81	1	64	1	90	0	0
1980	Winter	5	178	4	227	1	89	0	0
1981	Winter	4	135	0	0	1	76	0	0
1982	Winter	4	145	1	61	0	0	0	0
1983	Winter	2	70	0	0	0	0	2	273
1984	Winter	2	77	1	68	1	78	1	122
1985	Winter	0	0	0	0	0	0	0	0
1986	Winter	0	0	0	0	0	0	0	0
1987	Winter	0	0	0	0	0	0	0	0
1988	Winter	1	41	2	110	0	0	0	0
1989	Winter	1	27	1	50	1	77	0	0
1990	Winter	7	258	1	53	0	0	0	0
1991	Winter	3	113	0	0	0	0	0	0
1992	Winter	2	69	0	0	0	0	0	0
1993	Winter	2	77	1	61	0	0	0	0
1994	Winter	3	89	0	0	0	0	0	0
1995	Winter	6	197	1	50	0	0	0	0
1996	Winter	4	152	3	176	0	0	0	0
1997	Winter	4	134	1	60	1	75	1	111
1998	Winter	7	197	1	67	0	0	0	0
1999	Winter	4	148	2	140	2	167	0	0
2000	Winter	6	210	1	58	0	0	1	103
2001	Winter	2	60	1	71	1	80	0	0
2002	Winter	4	128	2	138	0	0	0	0

Continued

Continued

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
2003	Winter	1	33	1	65	0	0	0	0
2004	Winter	4	152	1	50	0	0	1	247
2005	Winter	2	62	1	51	0	0	0	0
2006	Winter	3	104	3	173	0	0	0	0
2007	Winter	3	82	5	301	0	0	2	255
2008	Winter	2	73	2	121	0	0	1	170

Consolidated data of heavy rain in Rajshahi district (mm) – Summer

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1974	Summer	2	69	0	0	0	0	0	0
1975	Summer	3	123	1	66	0	0	0	0
1976	Summer	1	37	0	0	0	0	0	0
1977	Summer	1	43	2	116	1	98	1	170
1978	Summer	2	57	1	52	2	161	1	186
1979	Summer	4	147	1	69	0	0	1	101
1980	Summer	2	52	0	0	0	0	0	0
1981	Summer	4	138	0	0	1	99	1	184
1982	Summer	3	92	1	60	0	0	0	0
1983	Summer	5	212	0	0	1	81	0	0
1984	Summer	2	75	0	0	1	98	0	0
1985	Summer	0	0	0	0	0	0	0	0
1986	Summer	0	0	0	0	0	0	0	0
1987	Summer	0	0	0	0	0	0	0	0
1988	Summer	2	70	0	0	0	0	0	0
1989	Summer	3	89	0	0	1	89	0	0
1990	Summer	2	60	4	250	0	0	0	0
1991	Summer	4	157	2	127	0	0	0	0
1992	Summer	2	66	0	0	0	0	0	0
1993	Summer	1	33	1	51	2	159	0	0
1994	Summer	3	100	0	0	1	75	0	0
1995	Summer	2	62	1	67	0	0	0	0
1996	Summer	1	40	0	0	0	0	0	0
1997	Summer	7	224	2	117	0	0	1	130
1998	Summer	3	105	2	145	1	87	0	0
1999	Summer	7	240	0	0	2	167	0	0
2000	Summer	2	55	0	0	1	78	0	0
2001	Summer	1	36	0	0	1	90	1	109
2002	Summer	5	187	1	53	0	0	0	0
2003	Summer	3	106	3	175	0	0	0	0
2004	Summer	4	126	2	109	1	86	0	0
2005	Summer	3	84	1	58	1	79	1	151
2006	Summer	4	139	0	0	0	0	0	0
2007	Summer	5	164	0	0	0	0	0	0
2008	Summer	2	68	0	0	0	0	0	0

Annexure 5

Consolidated data of heavy rain in Mymensingh district (mm) – Southwest monsoon

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1977	Southwest monsoon	12	395	3	172	1	83	0	0
1978	Southwest monsoon	6	197	1	58	0	0	0	0
1979	Southwest monsoon	3	105	0	0	1	78	0	0
1980	Southwest monsoon	8	276	4	241	0	0	1	116
1981	Southwest monsoon	12	462	2	117	0	0	1	146
1982	Southwest monsoon	6	213	4	278	2	172	2	227
1983	Southwest monsoon	10	335	4	239	2	175	1	106
1984	Southwest monsoon	8	255	9	531	0	0	1	109
1985	Southwest monsoon	4	132	1	66	0	0	0	0
1986	Southwest monsoon	9	325	5	291	0	0	4	530
1987	Southwest monsoon	8	300	0	0	0	0	2	294
1988	Southwest monsoon	10	348	4	219	0	0	1	145
1989	Southwest monsoon	5	165	3	183	1	81	2	291
1990	Southwest monsoon	10	332	3	191	1	99	2	227
1991	Southwest monsoon	11	373	4	247	2	166	1	102
1992	Southwest monsoon	8	258	2	121	0	0	0	0
1993	Southwest monsoon	11	384	4	230	4	325	0	0
1994	Southwest monsoon	5	169	3	193	0	0	0	0

Continued

Continued

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1995	Southwest monsoon	8	292	8	519	3	255	1	119
1996	Southwest monsoon	5	185	0	0	0	0	0	0
1997	Southwest monsoon	11	408	1	69	1	76	1	107
1998	Southwest monsoon	11	370	5	278	0	0	0	0
1999	Southwest monsoon	11	369	2	110	2	179	0	0
2000	Southwest monsoon	12	379	4	217	0	0	0	0
2001	Southwest monsoon	7	233	2	126	0	0	2	232
2002	Southwest monsoon	9	319	3	181	1	82	1	147
2003	Southwest monsoon	7	238	2	112	0	0	0	0
2004	Southwest monsoon	9	320	0	0	1	84	5	1403
2005	Southwest monsoon	12	387	1	58	1	75	0	0
2006	Southwest monsoon	6	204	2	104	1	86	0	0
2007	Southwest monsoon	8	281	6	357	1	89	1	152
2008	Southwest monsoon	8	290	2	121	0	0	2	238

Consolidated data of heavy rain in Mymensingh district (mm) – Northeast monsoon

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1977	Northeast monsoon	0	0	0	0	0	0	0	0
1978	Northeast monsoon	1	32	0	0	0	0	0	0
1979	Northeast monsoon	0	0	0	0	0	0	0	0
1980	Northeast monsoon	1	25	0	0	0	0	1	120
1981	Northeast monsoon	0	0	1	60	0	0	0	0
1982	Northeast monsoon	0	0	0	0	0	0	0	0
1983	Northeast monsoon	1	48	0	0	0	0	2	212
1984	Northeast monsoon	2	70	0	0	0	0	0	0
1985	Northeast monsoon	1	35	0	0	0	0	0	0
1986	Northeast monsoon	1	26	0	0	1	77	0	0
1987	Northeast monsoon	1	48	0	0	0	0	0	0
1988	Northeast monsoon	0	0	2	107	0	0	1	103
1989	Northeast monsoon	1	46	0	0	2	180	0	0
1990	Northeast monsoon	0	0	0	0	0	0	0	0
1991	Northeast monsoon	2	69	0	0	0	0	2	487
1992	Northeast monsoon	3	89	0	0	0	0	1	116
1993	Northeast monsoon	3	118	1	51	0	0	0	0
1994	Northeast monsoon	0	0	1	66	0	0	0	0

Continued

Continued

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1995	Northeast monsoon	2	85	0	0	0	0	0	0
1996	Northeast monsoon	1	29	0	0	0	0	1	156
1997	Northeast monsoon	0	0	0	0	0	0	0	0
1998	Northeast monsoon	0	0	0	0	0	0	0	0
1999	Northeast monsoon	1	28	1	68	1	79	0	0
2000	Northeast monsoon	0	0	1	50	1	78	0	0
2001	Northeast monsoon	0	0	0	0	0	0	0	0
2002	Northeast monsoon	0	0	0	0	1	76	0	0
2003	Northeast monsoon	0	0	1	57	0	0	1	100
2004	Northeast monsoon	0	0	1	61	0	0	0	0
2005	Northeast monsoon	1	38	0	0	0	0	1	125
2006	Northeast monsoon	0	0	0	0	0	0	0	0
2007	Northeast monsoon	1	37	1	65	1	81	0	0
2008	Northeast monsoon	1	47	0	0	0	0	1	101

Consolidated data of heavy rain in Mymensingh district (mm) – Winter

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1977	Winter	8	302	3	154	1	77	3	367
1978	Winter	5	168	0	0	3	252	1	175
1979	Winter	2	55	1	51	0	0	0	0
1980	Winter	6	205	3	195	1	90	0	0
1981	Winter	4	123	2	129	1	91	0	0
1982	Winter	2	65	3	167	0	0	2	264
1983	Winter	4	134	1	71	0	0	3	369
1984	Winter	3	97	4	234	1	86	0	0
1985	Winter	5	182	1	67	1	75	0	0
1986	Winter	8	259	2	120	1	85	1	103
1987	Winter	5	173	4	251	1	97	1	127
1988	Winter	7	274	2	111	1	96	1	147
1989	Winter	5	173	5	271	0	0	0	0
1990	Winter	9	258	3	166	2	181	0	0
1991	Winter	11	420	2	112	1	79	1	207
1992	Winter	7	207	1	52	0	0	0	0
1993	Winter	6	217	6	386	1	80	4	510
1994	Winter	7	243	1	59	0	0	0	0
1995	Winter	3	119	1	54	1	95	0	0
1996	Winter	3	112	2	128	1	91	0	0
1997	Winter	10	369	1	52	0	0	1	138
1998	Winter	7	263	0	0	0	0	1	197
1999	Winter	4	139	3	182	0	0	0	0
2000	Winter	10	345	0	0	1	81	0	0
2001	Winter	6	229	0	0	2	166	0	0
2002	Winter	8	271	0	0	0	0	0	0
2003	Winter	5	166	1	58	1	75	0	0
2004	Winter	6	187	3	181	0	0	0	0
2005	Winter	12	458	2	122	1	83	0	0
2006	Winter	12	386	1	51	1	90	1	134
2007	Winter	9	314	1	65	2	166	2	248
2008	Winter	4	162	0	0	1	84	2	248

Consolidated data of heavy rain in Mymensingh district (mm) – Summer

		25 <50		50 <75		75 <100		More than 100	
		Days	Sum	Days	Sum	Days	Sum	Days	Sum
1977	Summer	1	29	4	246	3	260	0	0
1978	Summer	6	239	1	59	0	0	0	0
1979	Summer	0	0	0	0	0	0	0	0
1980	Summer	3	105	2	122	0	0	0	0
1981	Summer	2	62	1	63	1	77	1	124
1982	Summer	4	120	0	0	1	99	0	0
1983	Summer	2	71	1	63	0	0	2	327
1984	Summer	3	112	1	56	1	90	1	165
1985	Summer	2	62	1	55	0	0	0	0
1986	Summer	3	109	3	158	0	0	1	202
1987	Summer	7	228	0	0	0	0	0	0
1988	Summer	9	270	3	195	0	0	1	261
1989	Summer	4	143	0	0	0	0	0	0
1990	Summer	5	140	1	71	1	77	0	0
1991	Summer	4	128	2	102	0	0	0	0
1992	Summer	3	94	0	0	0	0	0	0
1993	Summer	7	211	0	0	0	0	0	0
1994	Summer	2	81	1	69	0	0	0	0
1995	Summer	2	51	3	167	0	0	0	0
1996	Summer	4	166	0	0	1	80	0	0
1997	Summer	6	249	0	0	0	0	0	0
1998	Summer	7	240	1	66	1	92	1	125
1999	Summer	4	135	1	64	1	79	0	0
2000	Summer	6	216	1	62	0	0	1	117
2001	Summer	2	69	0	0	1	93	1	116
2002	Summer	7	232	2	125	0	0	1	162
2003	Summer	3	99	1	59	0	0	1	100
2004	Summer	5	171	1	53	0	0	0	0
2005	Summer	5	195	3	181	0	0	1	157
2006	Summer	3	107	3	166	0	0	0	0
2007	Summer	5	167	2	118	0	0	0	0
2008	Summer	4	145	1	72	0	0	0	0

About ICRISAT

ICRISAT Science with a human face

International Crops Research Institute for the Semi-Arid Tropics

ICRISAT is a member of the CGIAR Consortium

The **International Crops Research Institute for the Semi-Arid Tropics** (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in Asia and sub-Saharan Africa with a wide array of partners throughout the world. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid tropics have over 2 billion people, of whom 644 million are the poorest of the poor. ICRISAT innovations help the dryland poor move from poverty to prosperity by harnessing markets while managing risks – a strategy called Inclusive Market-Oriented Development (IMOD).

ICRISAT is headquartered in Patancheru, Telangana, India, with two regional hubs and six country offices in sub-Saharan Africa. It is a member of the CGIAR Consortium. CGIAR is a global research partnership for a food secure future.

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