URBAN INFLUENCES ON SELECTED CLIMATIC PARAMETERS IN DHAKA METROPOLITAN AREA

BY

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In partial fulfillment of the requirements for the Degree of Master of Engineering (Water Resources)

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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

DHAKA

February 1998

CERTIFICATE

THIS IS TO CERTIFY THAT THIS PROJECT WORK HAS BEEN DONE BY ME AND NEITHER THIS PROJECT NOR ANY PART THEREOF HAS BEEN SUBMITTED ELSEWHERE FOR THE AWARD OF ANY DEGREE OR DIPLOMA.

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February 1998

We hereby recommend that the project work prepared by Md. Asaduzzaman entitled "URBAN INFLUENCES ON SELECTED CLIMATIC PARAMETERS IN DHAKA METROPOLITAN AREA" be accepted as fulfilling this part of the requirements for the degree of Master of Engineering (Water Resources).

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ABSTRACT

In this study, efforts have been made to study the effect of urbanization on selected climatic parameters such as rainfall, surface temperature and atmospheric pressure for Dhaka metropolitan area. The development of Dhaka metropolis was very rapid between the 70's and 90's of this century. Dhaka city is often criticized as the city of unplanned growth, which if continued would have adverse effects on the environment and economy. An understanding of the changes in the magnitude of rainfall, surface temperature and atmospheric pressure due to increased urbanization is essential for proper land use planning and checking unplanned growth of metropolitan area. Mymensingh and Tangail have been chosen together with Dhaka city to compare the changes of climatic parameters between less urban area and a highly urban area. The annual and seasonal data were studied for the period from 1953 to 1995 for Dhaka, 1951 to 1995 for Mymensingh and 1962 to 1995 for Tangail. The data required for this study are daily values of rainfall, maximum temperature, minimum temperature and atmospheric pressure.

Changing trends of summer, monsoon and annual data series of rainfall for Dhaka show different patterns from that of less urban area i.e. Mymensingh and Tangail. Annual rainfall and monsoon rainfall of Dhaka does not show any significantly increasing or decreasing trend; only the pre-monsoon rainfall shows a linearly increasing trend. One day annual maximum rainfall and the number of monsoon rainy days for Dhaka exhibit a significantly decreasing trend. Whereas, these data series of rainfall for Mymensingh and Tangail show a significantly increasing trend. Coefficient of variation of mean monthly rainfall is less in Dhaka than the other two less urban stations. Significantly decreasing trend of coefficient of variation of annual rainfall for Dhaka and Tangail provides the evidence that the increase in the rainfall variability is occurring at a slower rate, and this rate of decreasing tendency is more in Dhaka than Tangail. The decreasing trend of coefficient of variation of annual rainfall for Mymensingh is not significant.

Surface temperature in Dhaka, a rapidly growing urban area, exhibits an increasing trend during the last two to three decades compared to less urban area. Significant urban heating effects have apparently taken place in Dhaka, as urban-affected temperature increase of 0.75^0C to 1.15^0C over 43-year period have been found in this study. In contrast, temperature for less

urban area, showed decreasing trend over this period. The urban warming appears to be predominant in minimum temperature displaying considerately more increase than maximum temperature. Increasing annual mean temperature in Dhaka indicates that the greatest contribution to the warming of the mean temperature is due to the increase in minimum temperature. One day annual maximum and minimum temperatures of Dhaka increase by about 1.15^0C and 2.4^0C, respectively over the 43 year period; while Mymensingh showing a small downward trend exhibits the characteristics of a non-urban area.. It appears from this study that change in temperature i.e. urban warming is taking place in Dhaka.

Average annual atmospheric pressure of Dhaka and Mymensingh are 1007.7 mb and 1008.5 mb respectively. Annual atmospheric pressure of above stations exhibit year to year variation. A significantly increasing change in annual average atmospheric pressure has been found in Dhaka, but not in Mymensingh.

ACKNOWLEDGMENT

The author gratefully acknowledges his profound gratitude and indebtedness to his supervisor, Dr. M. Fazlul Bari, Professor of the Department of Water Resources Engineering, Bangladesh University of Engineering and Technology (BUET), Dhaka for his supervision, guidance and encouragement throughout the course of this research. His active interest in the topic and valuable advice throughout the study were of immense help.

Gratitude is also expressed to the members of the Board of Examiners Dr. M. Monowar Hossain, Professor and Dr. Muhammed Ali Bhuyian, Professor of the Department of Water Resources Engineering of BUET for their valuable suggestions. Sincere thanks are also due to the staff of the Department of Water Resources Engineering of BUET and Development Design Consultants (DDC) Ltd. for their assistance. The author wishes to express his sincere gratitude to his friends and colleagues for their moral support during the entire period of study.

The author likes to thank Dr. Azizur Rahman, Team Leader, Muhuri Accreted Area Project and Noor Hossain Sarker, Director, Water Resources and Environment, DDC Ltd. for their cooperation in preparation and in providing access to computer facilities for this study.

Lastly, I express my gratitude to my mother, elder brother, wife, children and relatives for their patience and encouragement while carrying out this study.

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Introduction

1.1 Urban Influences on Climate

The study of urban climatology is a relatively recent field of climatology. It has developed as a result of artificial inadvertent climate modification. Such inadvertent modifications mainly arise due to population concentration, rapid urbanization and industrialization and due to development of dense mass transportation system. Almost all the meteorological parameters such as temperature, humidity, wind, rainfall etc. may be modified due to urbanization.

The climate of most urban areas differs from that of the surrounding country side. This may be partly due to the bias in the location of cities with respect to topography, but it primarily results from the distinct land surface characteristics and air quality in the urban area. One particularly notable feature of an urban area is the heat island effect, which leads to higher urban temperatures, particularly at night.

During the past 15 to 20 years, hydrologists have paid considerable attention to the effects of urbanization. Early works in urban hydrology were concerned with the effects of urbanization on the flood potential of small urban watersheds. The effects of urbanization on the flood hydrograph include increased total runoff volumes and peak flow rates.

Climate variations can be caused by both natural as well as anthropogenic or human factors. With increasing global population and advancing technology, human activity has become a fundamental component of climate change. Changes in land use alter surface reflectivity, surface temperatures, evaporation, water retention and runoff. These changes impact the local energy and water balance. On the global scale, industrialized societies have been adding radiatively active trace gases and aerosols to the atmosphere at an ever-increasing rate. The impact on climate of changes in atmospheric composition is at present only dimly perceived, but it is abundantly clear that today's climate statistic cannot be confidently projected into the next century. Thus increased uncertainty regarding the impact of climate on water supply, the structural integrity of facilities and

hydrograph statistics including extreme storm events will be a factor in long-term hydrologic planning and management for the foreseeable future.

1.2 Review of Previous Studies

The problem of climate changes and trends due to urbanization has been studied in the different countries like India, USA, USSR, Australia etc. by a number of investigators. A review of literature is presented below:

Towards the end of the nineteenth century, scientists from the India Meteorological Department started analyzing the available annual rainfall and temperature data over India and studied year to year variability in the rainfall and temperature. Blanford (1886) was the first meteorologist to make extensive studies of Indian rainfall. The analysis of 19 years (1867-1885) annual rainfall data for India as a whole did not reveal any systematic trend. Sarker and Thapliyal (1988) and Thapliyal (1990) studied the long period (1875-1989) annual rainfall of India, but the analysis of the data did not reveal any significant trend. They also studied the trends in long period temperature data from 70 stations well distributed over India. The temperature anomalies for the entire period indicated a slight warming trend of the order of $0.4^{o}C$ during the last 89 years. Hingane et. al. (1985) studied temperature data for the same stations and similar results were obtained. Scientists from the India Meteorological Department also analyzed the land surface temperature data of India. The annual maximum and minimum temperature of 20 meteorological observatories situated in India and neighborhood were studied by Pramanik and Jagannathan (1954). The study revealed that there is no general tendency of any systematic increase or decrease of temperature. Jagannathan (1963) and Jagannathan and Parthasarathy (1972) have analyzed the trends in the characteristics of seasonal variation of temperature in arid and semi-arid regions of the globe, and no systematic increase or decrease were observed by them in the mean annual temperature of Indian stations. Recently,

Mapping of the urban temperature was undertaken for the first time in India over the industrial city of Pune by Daniel and Krishnamurthy (1973) and the metropolitan city of Bombay by Philip et al. (1973). Sastry (1982) studied such effect in the case of industrial city of Visakhapatnam. Pradhen and Menon (1986) studied the heat island effect over Bhupal and indicated that even over a small city like Bhupal the effect of urbanization is pronounced and temperature increase was found during the winter months. Thapliyal and Kulshrestha (1991)

have studied the climate change or trend over India with particular reference to rainfall, surface temperature and atmospheric pressure during the period of about 120 years from 1870. The important climatic parameters over India showed considerable year to year random fluctuations. Except for temperature which has shown slight warming within the limits of one standard deviation over a century, rainfall and pressure do not indicate any systematic decreasing or increasing trend throughout the period. But, fluctuating epochal decreasing or increasing trends have been noted in the surface temperature and rainfall patterns in India.

Cayan and Douglus (1984) noted that in the southwestern United States, the temperature signal is often contaminated by urban heat island effect and such effect may have become significant with large urban developments during the past few decades. The trend of average surface temperature over the region for the 1941-80 periods shows warming in summer, cooling in spring and fall, and little noticeable change in winter, with maximum linear trends of about $\pm$ 0.03^{o} C/yr. A number of studies have documented the heat island effect of selected cities (Garstang et al., 1975; Oke, 1978; Landsberg, 1981). Landsberg points out that the urban heat island is a universal effect due to an altered radiation budget in the urban locale, but is modulated by a host of variables including size of the urban development, topography and surface characteristics and meteorological conditions. The urban-influenced boundary layer is confined to the lowest few hundred meters over the ground as seen in San Francisco (Duckworth and Sandberg, 1954), New York City (Bernstein, 1968) and Montreal (Oke and East, 1971). Evidence suggests that the urban-rural temperature contrast is maximum during the night, and hence reflected most in the daily minimum temperatures. Also the urban heat island appears to vary seasonally, but with large differences in character between individual cities. Several authors have considered the rise of urban temperature with time over a historical temperature record (Landsberg, 1981). Dornia (1967) estimated an urban temperature rise over a 90 year period (1871-1960) of about 0.008^{o} C/yr as a worldwide average.

Comprehensive analysis of temperature trends (e.g. Jones et al., 1986) provides fairly convincing evidence that on a global basis the atmosphere near the earth's surface is warmer now. There have been suggestions that a part of the warming, at least, might be a symptom of growth in the centers of population: so called urban heat island effect. In studies of data from a large number of cities in the northern hemisphere, Jones et al. (1989) estimated that earlier analysis of global trends may contain a spurious urban induced component of order + 0.1^{o}C for the first eight decades of this century. Karl et al. (1988) have described recently one

means of accounting for urbanization in temperature records from sites in the United States of America, by developing expressions statistically to estimate the difference in annual mean temperatures between an urban location and an adjacent non-urban one as a function of the population of that urban settlement.

According to Coughlan et al. (1990) trends which have occurred in urban-rural differences of maximum and minimum temperature at each of six large Australian coastal cities over the past 25 to 45 years indicate that temperatures at the urban sites are being affected by urbanization in their vicinity. These trends were least at the smallest of the cities.

In Bangladesh, rainfall analysis (frequency, distribution, rainfall pattern etc.) have been studied by a number of investigators and different projects to assess flood magnitude and drainage parameters. Matin and Ahmed (1983) studied the daily rainfall for estimating the intensity duration frequency relationship for the North-Eastern region and Ahmed (1986) studied the long duration extreme value rainfall data for the North-West region. Akhter (1992) studied the selection of statistical distributions for extremes of precipitation in South-East region and Siddique (1993) analyzed the extreme value of rainfall data of some selected urban regions of Bangladesh. Karmakar and Khatoon (1994) studied the temporal and spatial distributions of mean monthly rainfall and its variability together with the spatial distributions of the probabilistic estimates of rainfall extremes over Bangladesh during the south-west monsoon season. The study revealed that the mean monthly rainfall increases from June to July at most places over Bangladesh and then decreases up to September. The variability of rainfall decreases with increasing rainfall up to July at many places and then increases up to September. The study also revealed that the mean rainfall and the probabilistic rainfall extreme are minimum over the south-eastern and north-eastern parts of the country where the variability of rainfall is low. Also analysis of temperature for Bangladesh have been undertaken by a number of investigators mainly from the agricultural point of view. Manalo (1975) described the characteristic features of the climatic regimes of the country. Ahmed and Mobassher (1989) have studied the temporal and spatial variations of the absolute maximum temperature using 27 years data of 16 stations of Bangladesh.

Asian Development Bank (1994) studied the climate change in Bangladesh. Observations in Bangladesh indicate that there has been little or no increase in the average annual temperature in the country over the last four decades. On the other hand, the records on rainfall showed definite trends of increase. The study

included the annual rainfall data of over 20 stations in Bangladesh are available for the period between 1948 and 1990. Only the data for the 43-year periods (1948-1990) were examined in order to identify and trend or change in pattern. It showed a small tendency for rainfall for the nation as a whole to increase over time. The rate of increase is 0.19% per year if the multiplicative smoothing in accepted. However, the double exponential smoothing indicates no such tendency for rainfall either to increase or decrease. However, other smoothing methods like a 21-year moving average show the rate of increase to be 0.14% per year. On the whole, therefore, one can, for the time being, assume a small increasing tendency for rainfall in Bangladesh similarly an examination of the available historical data (1951-1990) on temperature has been made in order to identify trends and annual variability. Data for the highest maximum and lowest minimum temperatures were investigated for the period of 1961 to 1988. In order to identify the trend of mean daily temperature, both spatially and seasonally, decadal temperature data for four decades have been examined and indicated that:

- the highest maximum temperature in the country registered a decrease of $2^{o}C$ over a 28 year period (1961-1988) from $40.7^{o}C$ to $38.7^{o}C$;
- the lowest minimum temperature demonstrated a clear trend of increase over the same period by $1.5^{o}C$ from $7.4^{o}C$ to $8.9^{o}C$. In other words, the gap between the highest maximum and the lowest minimum temperate has narrowed over three decades from 1961 to 1988;
- in all the four regions of the country, North west, North east, south west and South east, there was a distinct fall in mean daily temperature from 1951 to 1990.
- the seasonal average temperatures also indicate a small, but discernible decrease for all the seasons.

1.3 Objectives of the Study

There is a need for a much more elaborate and exhaustive study encompassing both theoretical and applied aspects of climate change. The present study is an effort to fill this need partially. For this study, Dhaka metropolitan area has been selected. Surging population associated with large scale migration from village

area and industrilization in Dhaka is rapidly increasing which may lead to changes in the climatic paramaters. Dhaka city is becoming a mega city and more than 6% of total population of Bangladesh are living in Dhaka city. In general, almost all the climatological parameters such as temperature, rainfall, humidity, atmospheric pressure, wind, net radiation etc. are modified due to urban growth. Based on the instrumental observations of over a 40-year period available in Dhaka and Mymensingh, attempt has been made here to study if there is some evidence of any climate change or trends over Dhaka with particular reference to rainfall, surface temperature and atmospheric pressure.

The main objective of this study is to characterize the variability of selected climatic parameters due to influence of urbanization. Among various climatic parameters rainfall is of greatest concern. The inter-annual variability of the yearly and monsoon rainfall has considerable impact on urban drainage and national activities such as agriculture, water management and energy. For a tropical country like Bangladesh temperature near the surface of the ground is another important climatic parameter. A related climatic parameter of importance is surface atmospheric pressure. The pressure gradient exercises a controlling influence on all gradient winds; it is the factor that initiates horizontal air movement and therefore is of primary importance in determining the winds at any level at a given time. The atmospheric pressure has considerable influence on temperature and humidity and humidity is the source of precipitation and also materially controls the rates of evaporation from land and water. Available records of rainfall, surface temperature and atmospheric pressure over Dhaka metropolitan area will be analyzed:

- to investigate the trends in the variability of rainfall, surface temperature and atmospheric pressure in the Dhaka metropolitan area;

- to examine whether any significant changes have occurred in the selected climatic parameters by means of statistical tests;

- to compare the magnitude of changes of the selected parameters in the urban area with those for a relatively unaffected nearby non-urban area.

Chapter 2

Study Area And Data Collection

In this chapter, first a description of the study area and its population trend is provided. This is followed by a discussion about data need, their sources and data collection for this study.

2.1 Study Area

The study area is the Dhaka metropolitan area with an area of about 343 sq. km. It is situated between 23° 53′ and 24° 06′ north latitude and between 90° 01′ and 90° 37′ east longitude and consists of 15 thanas. According to 1991 census, the population in the Dhaka metropolitan area is approximately 4.2 million.

The study area is composed of alluvial terraces and low-lying areas. Dhaka city and the surrounding towns are located mainly on alluvial terraces, which are classified as a part of the Madhupur Tract of Pleistocene deposits.

The climate of the study area is classified as a tropical monsoon type, characterized by three distinct seasons: monsoon, cool and warm. The monsoon season is normally from June to September and 75% of annual rainfall in Dhaka occurs in monsoon season. Summer/ summer (March - May) is the transition season between the rainy season and the dry season. Some rainfall with thunder storms occurs in the Summer season. Post-monsoon is the dry season from October to November.

During monsoon, most of the annual rainfall occurs frequently accompanied by high intensity and some have duration of several days. Maximum temperatures are commonly in the 40°C range and coincide with high humidity and generally overcast skies. Destructive winds are frequent during both the early and the late stages of the monsoon season.

Following the monsoon, the cool season begins in November and continues through February. Cool days are usually with little or no rainfall. Minimum temperatures may drop to about 5°C. Maximum temperature are perennially under 35°C. The humidity is relatively low and the skies are generally clear.

The warm season, March and April, is characterized by high temperatures occasionally exceeding 40°C, accompanied by frequent violent thunder storms and winds ranging up to 9 km/hr. The humidity is generally low during this season.

Monthly evaporation varies from 75 mm to 130 mm depending upon locality. Rates are highest during the warm season and the lowest during the cool season.

2.2 Trend of Urbanization

Population : The study area covers the central part of the Dhaka Statistical Metropolitan Area (Dhaka SMA). Dhaka SMA includes Dhaka city corporation/ metropolitan areas and the adjacent areas having urban characteristics. The study area is shown in Figure 2.1. With its expolding population, Dhaka- the capital city of Bangladesh, is regarded as one of the fastest growing cities in the world. The population of the city between 1901 and 1931 was below 200,000. In the next 30 years the city added only 300,000 inhabitants, with the total population reaching 557,000 in 1961. But since then, the city has received a record number of people in the consecutive census periods. Specially after independence of Bangladesh in 1971, Dhaka received several hundred thousand people every year. As a result, the total population of the city jumped from 5,57,000 in 1961 to almost 3.6 million in 1991. The population increased from 410,000 in 1951 to 6,951,000 in 1991 in Dhaka SMA . According to 1991 census, the population of Dhaka metropolitan area is 3568,099. Table 2.1 shows the population in each census year in Dhaka SMA, Mymensingh and Bangladesh. Decadal wise changes in population growth rate in Dhaka SMA, Mymensingh and Bangladesh can be obtained from Table 2.1. It is seen from Table 2.1 that the decadal increase of population growth in Dhaka SMA compare to Bangladesh is more significant.

Various studies and surveys have indicated that the rapid growth of Dhaka's population is mainly caused by heavy influx of migrants from the vast rural areas. It is estimated that nearly 60 per cent of the present population of the city are migrants and in early 1970s the proportion of the migrant in the capital was higher 70-75 per cent. Evidence from many studies also indicate that a large number of Dhaka's migrant population were driven to the capital by their proverty at the source region which in turn was caused by different factors such as high rural population densities, rural landless, natural disasters, less opportunity of job, less increased earning source, famine, loss of husband or bread earner and long period of unemployment. Dhaka Metropolis is going to become a mega city. Population trend in Bangladesh, Dhaka SMA and Mymensingh municipality are shown in Figure 2.2. The population of Dhaka SMA has grown rapidly after 1960.

It is seen from the Figure 2.2 that the population growth rate in Dhaka SMA is increased in each decade, but after 1974, the population growth rate was significantly increased in Dhaka SMA. On the other hand, the increasing trend of population growth during 1951 to 1991 is approximately same in Bangladesh, and in Mymensingh, population growth rate

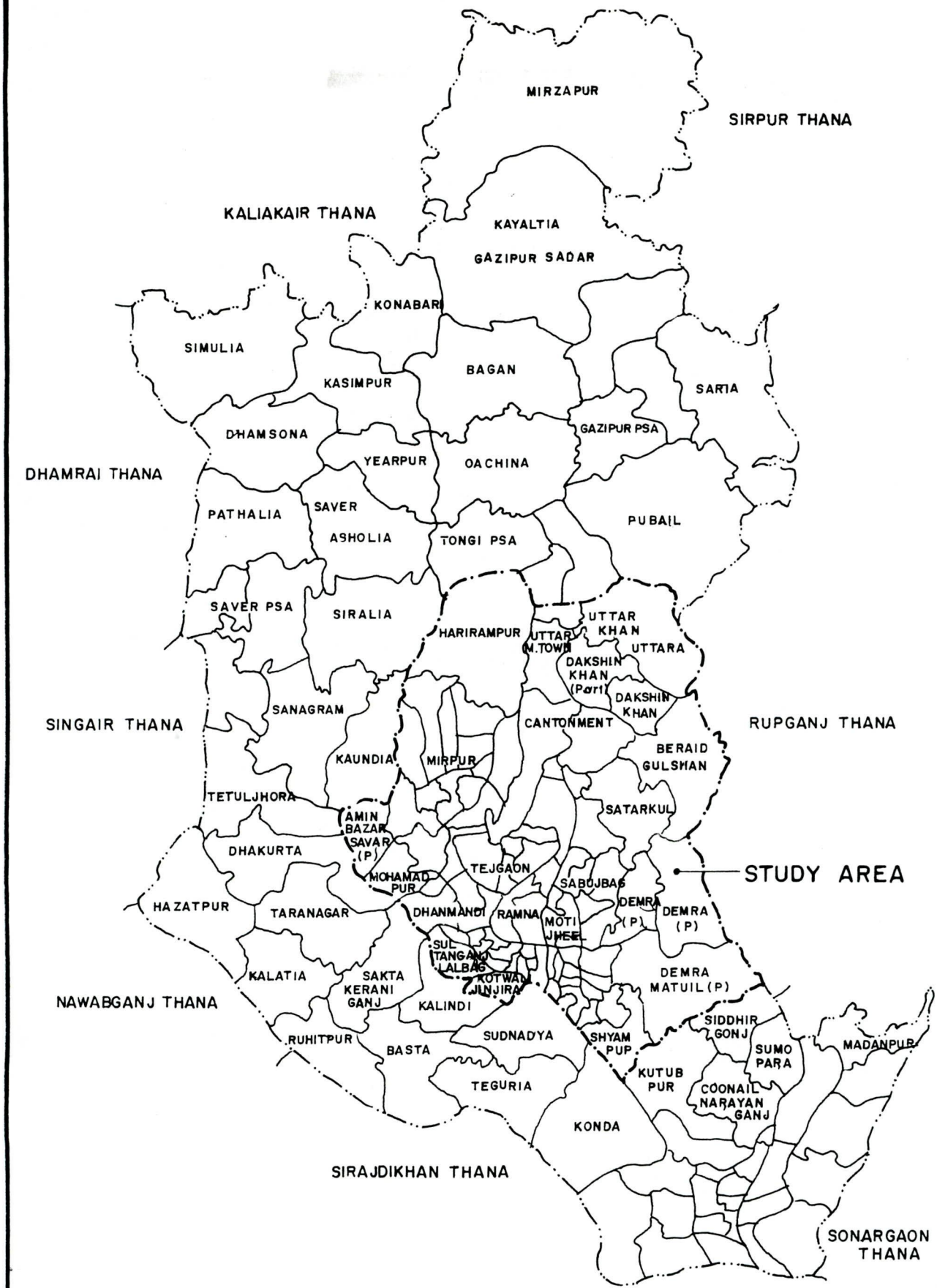


FIGURE 2.1 : STUDY AREA : DHAKA METROPOLITION AREA WITH DHAKA S.M.A

Table 2.1 Population census and decadal increase in Dhaka SMA, Mymensingh and Bangladesh

Year	Population (number)			Decadal increase (%)			Percent of country population living in Dhaka SMA
	Dhaka SMA	Mymensingh	Bangladesh	Dhaka SMA	Mymensingh	Bangladesh	
1951	404,301	44,527	44,165,740				0.915
				+77.78	+19.60	25.04	
1961	718,765	53,256	55,222,663				1.30
				+171.33	+242.0	38.35	
1974	1,950,222	182,153	76,398,000				2.55
				+75.89	+4.8	+17.69	
1981	3,430,311	190,911	89,912,000				3.82
				+102.63	+43.18	23.96	
1991	6,950,920	273,350	111,455,185				6.24

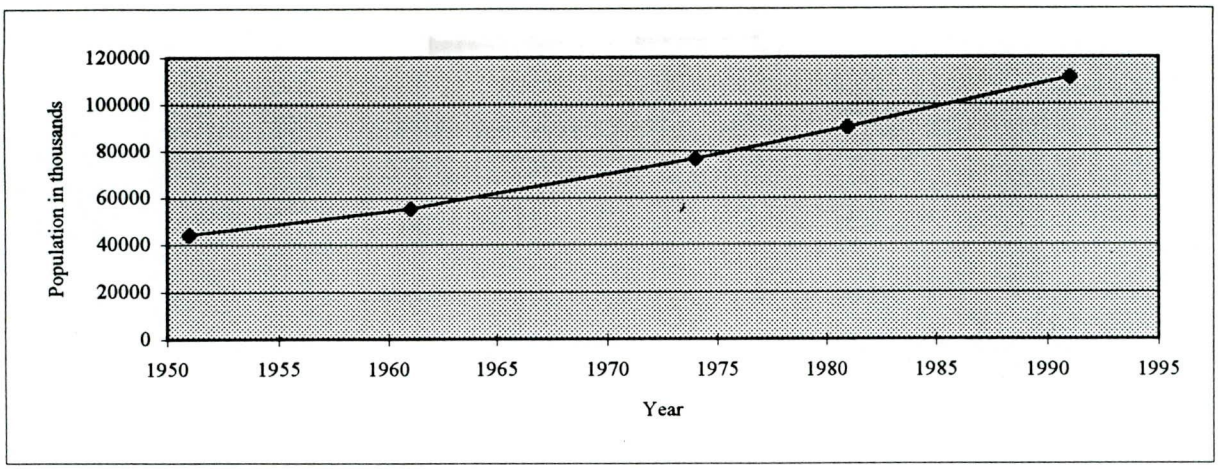


Figure a : Population trend of Bangladesh

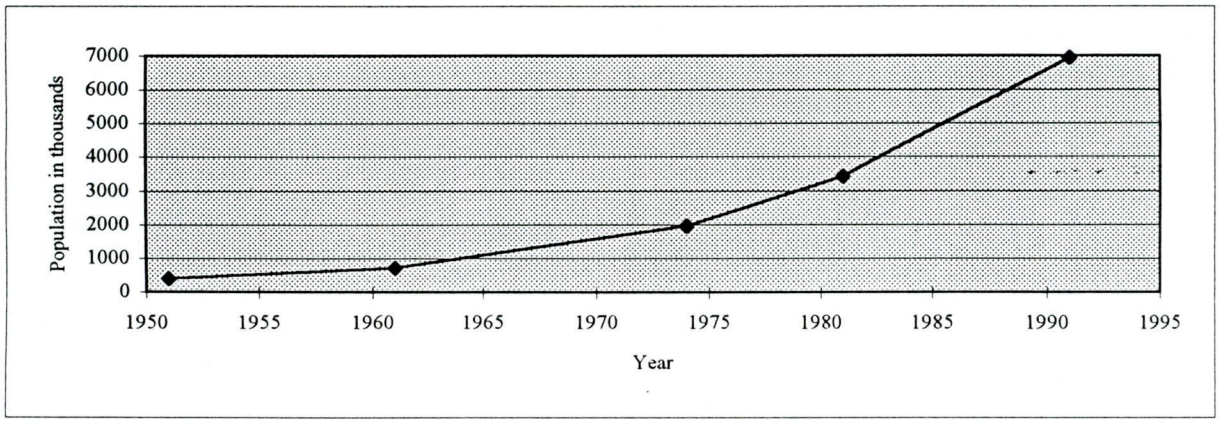


Figure b : Population trend of Dhaka SMA.

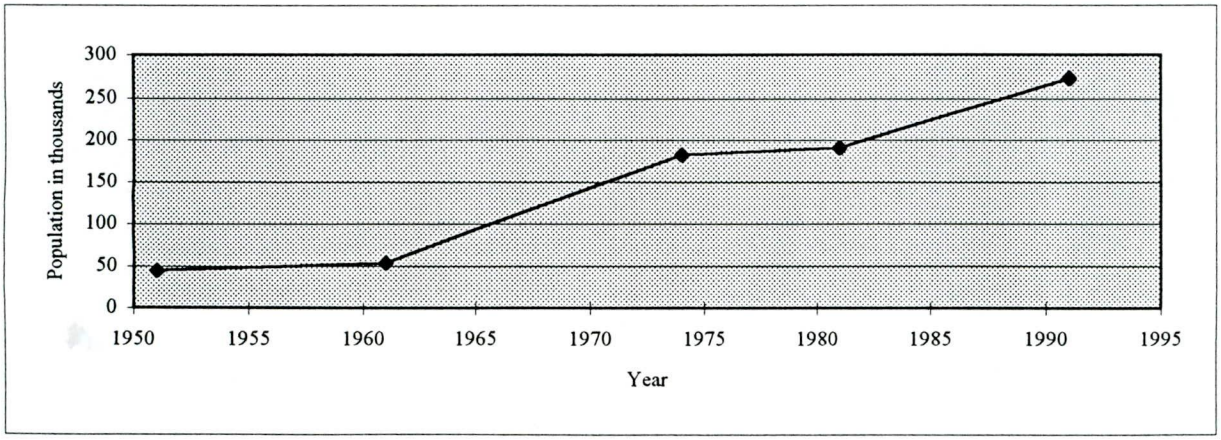


Figure c : Population trend of Mymensingh

Figure 2.2 : Trend of population of Bangladesh, Dhaka SMA and Mymensingh

was very low during 1951-1960 and 1974-1980 . Population density in Dhaka city and Mymensingh municipality from 1974 to 1991 are shown in Table 2.2. Population density is more higher in Dhaka than Mymensingh. Population density is decreased due to increase of city area.

Table 2.2 : Population density in Dhaka city and Mymensingh municipality.

Year	Population density (number per sq km)	
	Dhaka city	Mymensingh Municipality
1961	8,565	9,513
1974	14,294	7,814
1981	9,038	3,497
1991	10,403	2,984

Built-up Area: Due to huge increase in the population of Dhaka, the pressure on load for residential, commercial and industrial use has been very high. After 1975, there has been a new trend of housing development mainly in private sector. To meet the basic needs with the increased population a road networks are also increased. Table 2.3 presents the trend of rapid increased number of house hold in the Dhaka city.

Table 2.3 : House-hold increase trend in Dhaka city.

Year	Number of house-holds
1951	46,070
1961	93,985
1981	4,51,977
1991	7,43,768

Most of the area of Dhaka city is covered by multistoried residential/commercial buildings and road networks which are responsible for increasing high heat capacity and the trapping of long-wave radiation.

Solar radiation, the earth's chief source of energy, determines weather and climate. Differences in insolation are one of the primary factor in determining the general circulation of the earth's atmosphere. Solar radiation data has wide variety of use. Apart from providing information as potential source of solar energy, data are also important for architecture, engineers for designing of building and infrastructures and also planner particularly in urban areas. But solar radiation data in Bangladesh are very scarce. Helali,

(1988) and Helali et al (1988) studied the daily solar radiation in Dhaka and Bangladesh for the period 1982-1988. It revealed that the mean monthly average daily total radiation in Dhaka is about 323 cal/cm^2.day. The mean monthly average daily total radiation for Bangladesh is 314 cal/cm^2.day. The maximum, and minimum monthly average daily radiation in Bangladesh are found to be 407 cal/cm^2.day and 251 cal/cm^2.day occurring during the month of April in Dhaka and in January at Jessore respectively. From the above study, it is clear that the solar radiation is higher in Dhaka than any other places of Bangladesh. This increased albedo is due to rapid growth of urbanization, development of buildings, infrastructures, road networks, mass transportation and also reducing plantation, grass covered plain land, marshy land etc. day by day.

About half the incident radiation at the outer limits of the atmosphere eventually reaches earth's surface. Much of it is absorbed, but some is reflected to the atmosphere and to space. The albedo of earth's surface varies widely, depending on solar altitude and type of surface. It is less for green forest, grass-covered plains, marshy land, crop covered cultivated fields and moist soil surfaces than for dry, and tends to be less for high solar altitudes.

Industry : A radical change took place in the process of industrialization in and around the city of Dhaka with the creation of Bangladesh in 1971. The major industrial units are mainly located in the industrial zones of Narayanganj, Tejgaon and Tongi. Jute and textile, chemicals, metal, cigarette, machine tools, automobiles, hosieries, oil mills, tanneries, engineering workshop, printing press etc. are some of the of the major industries in this city. From Table 2.4 it is seen that the industrial growth rate also shows a increasing trend like population.

Table 2.4 : Industrial growth rate of Dhaka

Year	Number of Industries
1969-70	754
1972-73	1104
1977-78	1484
1983-84	2385
1988-89	4187
1991-92	4323

Source : Bangladesh Bureau of Statistics

Transport : The communication system of the Dhaka SMA has always been somewhat better than other urban area of the country as it enjoyed the privilege of being the capital

city. Communication facilities in SMA has been developed after the creation of Bangladesh and further developed after 1980 with a view to facilitate quick and safe journey to and from different parts of the country. Due to rapid increase of population in Dhaka city many new roads have been constructed and old ones have been reconstructed to allow the movement of increasing number of transport of different categories. Main means of land transports available in Dhaka SMA are bus, truck, mini-bus, car, jeep, taxi, motor cycle, auto rickshaw etc. Total length of the road in Dhaka SMA is 1691 km according to1981 census. Table 2.5 presents the transport growth rate of Dhaka city.

Large scale industrial activities and mass transportation are known to result in mechanism of changing the climatic parameter of the atmosphere near the earth's surface. Most of the pollution which affect the climate comes from two major sources, industry and increasing number of motor vehicles, and the salient parameters are those of suspended particulates, sulfer dioxide, nitrogen oxides, hydrocarbons, carbon monoxide, and lead. It is noticed that in Dhaka, air-quality conditions near the ground are poor due to dust, industrial emissions and vehicle emissions especially along the main roads.

Table 2.5 : Transportation growth rate of Dhaka

Year	Number of Transport
1971	35,458
1976	52,850
1981	80,603
1986	164,425
1987	176,315
1988	1,82,366

Source : Dhaka Metropolitan Police

2.3 Data Need

Following data are needed for this study :

- daily rainfall data
- daily maximum temperature data
- daily minimum temperature data
- daily atmospheric pressure data

2.4 Sources of Data

Hydrometeorological data are available from two organizations like, Bangladesh Water Development Board (BWDB) and Bangladesh Meteorological Department (BMD). BWDB mainly collects rainfall, river flow data and evaporation data. Basic data required for this study consist of rainfall, surface temperature and atmospheric pressure data. Main source of these data is the Bangladesh Meteorological Department which maintains a network of observation stations throughout Bangladesh to collect climatological data, such as rainfall, evaporation, wind speed, temperature, humidity, sunshine hour, atmospheric pressure etc. A index map of climatological data observation stations is shown in Figure 2.3. Another source of rainfall data is the Directorate of Surface Water Hydrology, BWDB. The required data are collected from Bangladesh Meteorological Department and Surface Water Hydrology, BWDB for three stations- Dhaka, Mymensingh and Tangail, and is shown in Table 2.6. For this study rainfall, temperature and atmospheric pressure data were collected for Dhaka and is shown in Table 2.6. For comparison of changes in these parameters observations from a nearby rural area was required. Mymensingh and Tangail were found to be the nearest stations that could be used for the purpose of comparison. For Mymensingh rainfall, temperature and atmospheric pressure data were available, but for Tangail only rainfall was available. Data for Mymensingh and Tangail are also shown in Table 2.6.

Table 2.6 : Rainfall, Temperature and Atmospheric pressure Data for Indicated Stations

Station	Source	Data and Length of Record			
		Rainfall	Maximum Temperature	Minimum Temperature	Atmospheric Pressure
Dhaka	BMD	1953-1995 (43 Years)	1953-1995 (43 Years)	1953-1995 (43 Years)	1953-1994 (42 Years)
	and				
	BWDB	1958-1995 (38 Years)	-	-	-
Mymensingh	BMD	1951-1995 (45 Years)	1951-1995 (45 Years)	1951-1995 (45 Years)	1951-1995 (45 Years)
	and				
	BWDB	1961-1995 (35 Years)	-	-	-
Tangail	BWDB	1962-1995 (34 Years)	-	-	-

Daily rainfall, maximum temperature, minimum temperature and atmospheric pressure data are read once a day. Monthly and annual data series and mean monthly and mean annual data series are computed from these readings. Mean daily temperature data is computed from the average of daily maximum and minimum temperature data. Sample of data sheets

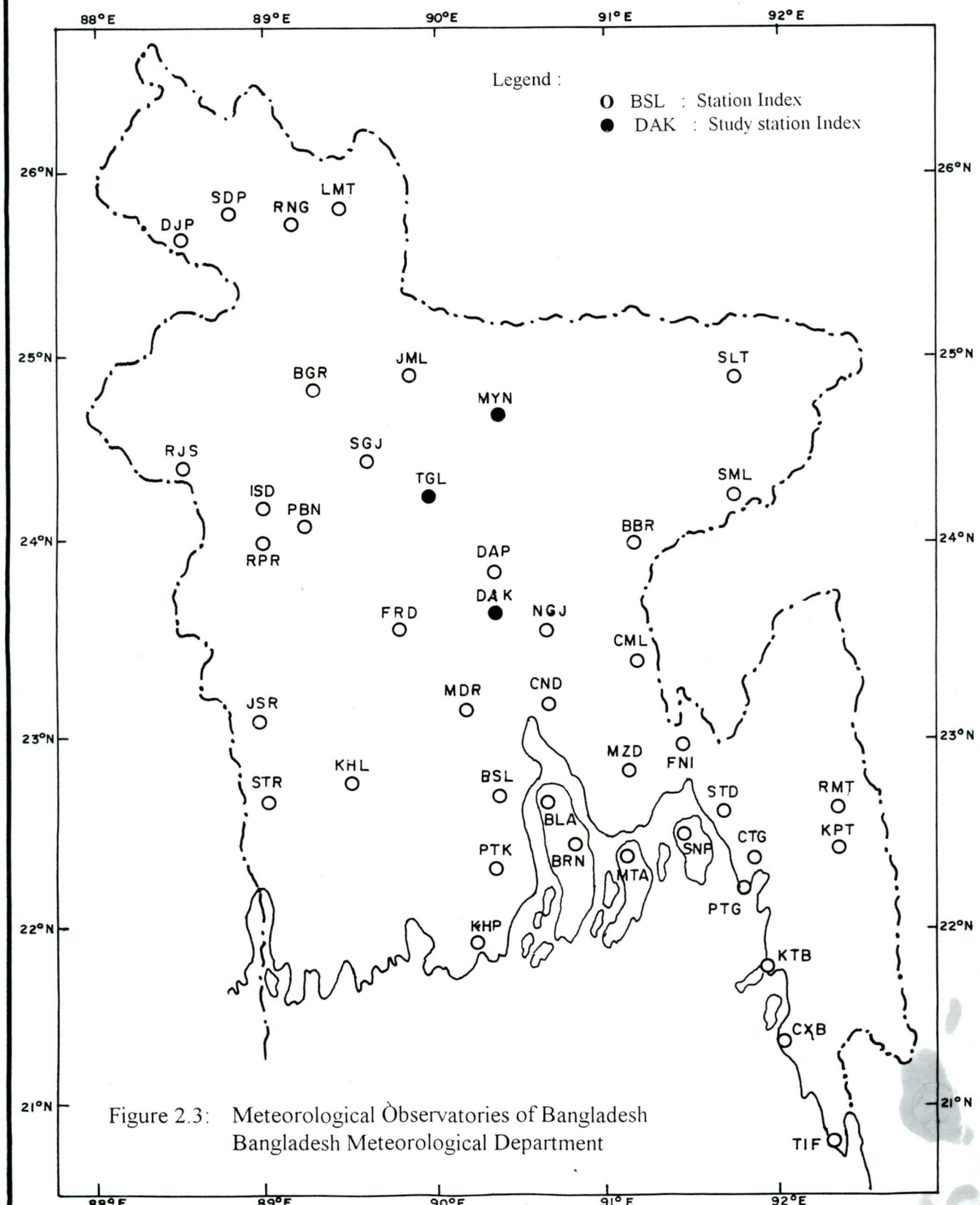


Figure 2.3: Meteorological Observatories of Bangladesh
Bangladesh Meteorological Department

of daily rainfall, daily maximum temperature, daily minimum temperature and daily atmospheric pressure are presented in Table A.1 through A.4 in Appendix-A.

After collection, data were checked for continuity and consistency. Missing data were filled by simple arithmetic average method and the normal ratio method depending on the variations of normal values of adjacent stations. After checking data were organized in a data base for further analysis. Records of missing data for rainfall, temperature and atmospheric pressure data series for Dhaka, Mymensingh and Tangail are also presented in Table 2.7.

Table 2.7 : Records of missing data for rainfall, temperature and atmospheric pressure data for indicated stations

Station	Source	Year of missing data			
		Rainfall	Maximum Temperature	Minimum Temperature	Atmospheric Pressure
Dhaka	BMD	1966 (Jan-Mar), 1971 (Mar, Apr & Dec), 1973 (Jul), 1974 (Jan-Dec)	1966 (Jan-Mar), 1971 (Mar, Apr & Dec), 1973 (Jul), 1974 (Jan-Dec)	1966 (Jan-Mar), 1971 (Mar, Apr & Dec), 1973 (Jul), 1974 (Jan-Dec)	1966 (Jan-Mar), 1971 (Mar, Apr & Dec), 1973 (Jul), 1974 (Jan-Dec)
	BWDB	1966 (Jan-Dec)	-	-	-
Mymensingh	BMD	1966 (Feb), 1969 (Jun), 1971 (Jan-Jul), 1972 (Oct, Mar),1973 (Jan-Dec) & 1974 (Jan-Dec)	1966 (Feb), 1969 (Jun), 1971 (Jan-Jul), 1973 (Mar, Sep-Dec) , 1974 (May-Jun, Nov-Dec) & 1977 (Jan-Dec)	1966 (Feb), 1969 (Jun), 1971 (Jan-Jul), 1973 (Mar, Sep-Dec) , 1974 (May-Jun, Nov-Dec) , 1977 (Jan-Dec) & 1981 (Jan-Dec)	1971 (Jan-Jul), 1973 (Mar, Sep-Dec) & 1974 (May,Jun, Nov-Dec)
	BWDB	1963 (Jun), 1971 (Apr), 1972 (Jan-Dec)	-	-	-
Tangail	BWDB	1971 (Apr), 1980 (Jan-Dec)	-	-	-

Chapter 3

Data Analysis

The primary objective of this analysis is to provide early warning of any changes in selected climatic parameters (rainfall, temperature, atmospheric pressure) due to rapid urbanization. This will involve statistical analysis of data to detect changes in selected parameters over time. From a statistical view point, all climatic parameters are considered random variables.

Different types of analyses are performed herein. Data are subjected to various statistical analyses in this chapter. The statistical analyses are necessary to ascertain whether or not there has been any incidence of change in selected climatic parameters.

3.1 Data Organization

Rainfall, temperature and atmospheric pressure data for Dhaka city (1953-1995), Mymensingh (1951-1995) were used for different analysis performed in the study. For Tangail only rainfall data for the period from 1962-1995 were available and included here. For purpose of analysis following data series shown in Table 3.1 were extracted from observed daily values.

Summer (pre-monsoon) season consists of three months from March to May, monsoon season consists of four months from June to September and winter season from December to February.

Each of the data series are subjected to following analysis :

- Tests for Normality
- Estimation of Trend
- Comparison of two period means
- Inter-annual and Monthly variability

3.2 Tests for Normality

Of all the commonly used probability distributions, normal distribution is used most widely. This is because the normal distribution is frequently used as a base distribution for comparison and for error analysis. In this study data were examined for normality by

several alternative methods, such as fitting empirical distribution, skewness test and chi-square goodness-of-fit test.

Table 3.1 : Data series used for different analysis

Data	Data series for analysis
Rainfall	Annual rainfall (mm) Summer rainfall (mm) Monsoon rainfall (mm) One day annual maximum rainfall (mm) Number of annual rainy days Number of Summer rainy days Number of monsoon rainy days
Temperature	Annual average maximum temperature Annual average minimum temperature Annual mean temperature Summer average maximum temperature Summer average minimum temperature Winter average maximum temperature Winter average minimum temperature One day annual maximum temperature One day annual minimum temperature
Atmospheric pressure	Annual average atmospheric pressure

3.2.1 Empirical Distribution

Empirical distribution of observations, generally represented frequency histograms, provide a visual indication of the symmetry of probability distributions. Histograms were constructed for each of the data series as mentioned in Table 3.1. For frequency tables, number of class intervals should be between 10 to 25 for hydrologic application (Yevjevich, 1972). Relative frequency provides an estimates of the probability of parameter observation in the indicated range or class interval.

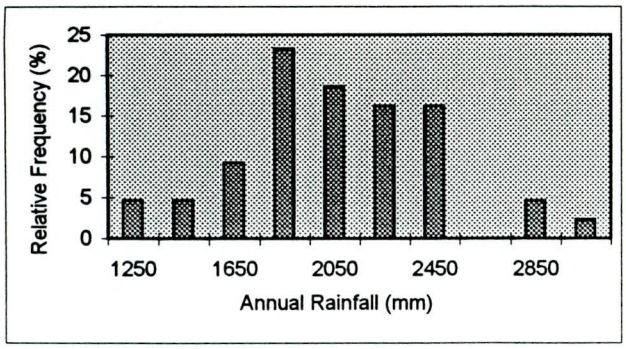
Rainfall histograms -- for different data series for Dhaka city are presented in Figures 3.1a to 3.1h and frequency tables are given in Table B.1 of Appendix-B. It is seen from above figures that frequency histogram of each data series of rainfall of Dhaka city appeared to be approximately normal except one day annual maximum rainfall and it is skewed to the right.

Similar rainfall histograms and frequency tables are given in Figures C.1a to C.1h in Appendix-C and Table B.2 in Appendix-B respectively for different data series of rainfall for Mymensingh. It is observed from these figures that frequency histogram of each data series of rainfall of Mymensingh appeared to be approximately normal except summer rainfall and number of monsoon rainy days. Summer rainfall of Mymensingh are appeared to be skewed to the right and number of monsoon rainy days is skewed to the left.

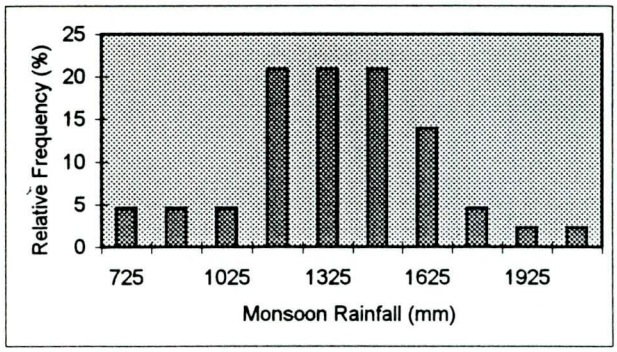
For Tangail, only rainfall was available and corresponding frequency tables are given in Table B.3 in Appendix-B and frequency histograms are given in Figures C.2a to C.2h in Appendix- C. It is seen from the figures that frequency histograms of each data series of rainfall of Tangail appeared to be approximately normal except one day annual maximum rainfall and it is skewed to the right.

Temperature histograms -- for various data series for Dhaka city are given in Figures 3.2a to 3.2i and frequency tables are given in Table B.4 in Appendix- B. It is observed from these figures that frequency histogram of each data series of temperature of Dhaka city appeared to be approximately normal except annual average maximum temperature, one day annual maximum temperature, one day annual minimum temperature and annual mean temperature. These histograms are appeared to be skewed to the right.

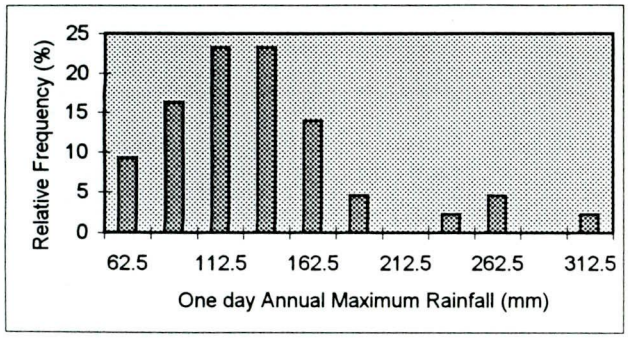
Similarly, temperature histograms are presented in Figures C.3a to C.3i in Appendix-C and frequency tables are given in Table B.5 in Appendix-B for different data series of temperature for Mymensingh. It is seen from these figures that the frequency histogram of each data series of temperature of Mymensingh appeared to be approximately normal except one day annual maximum temperature, one day annual minimum temperature and summer average minimum temperature. One day annual maximum temperature, one day annual minimum temperature and summer average minimum temperature are appeared to be skewed to the left.



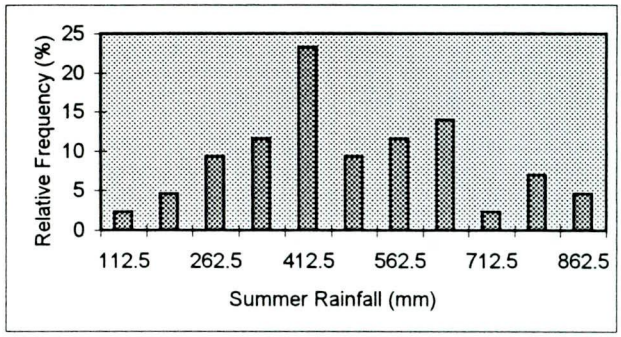
(a) Annual rainfall



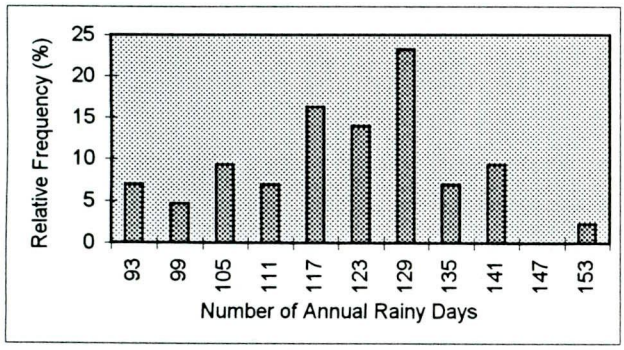
(b) Monsoon rainfall



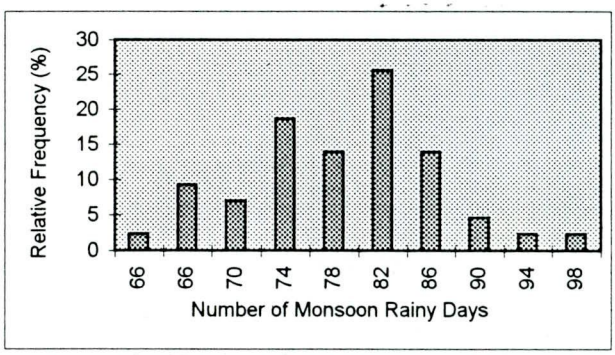
(c) One day annual maximum rainfall



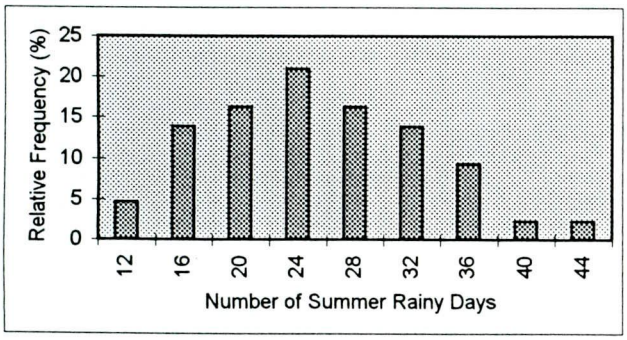
(d) Summer rainfall



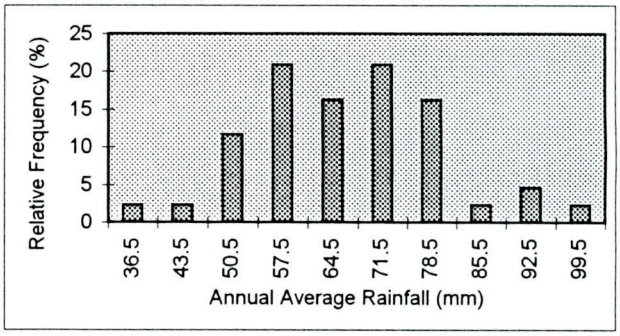
(e) Number of annual rainy days



(f) Number of monsoon rainy days

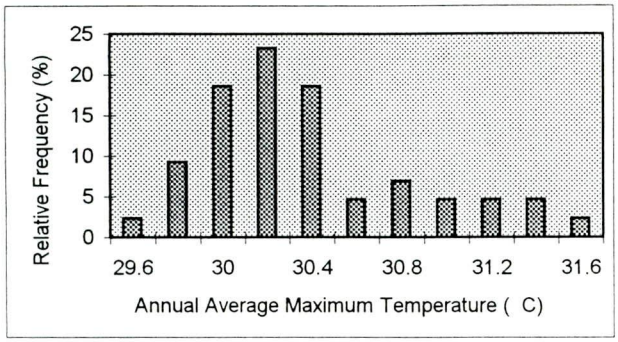


(g) Number of Summer rainy days

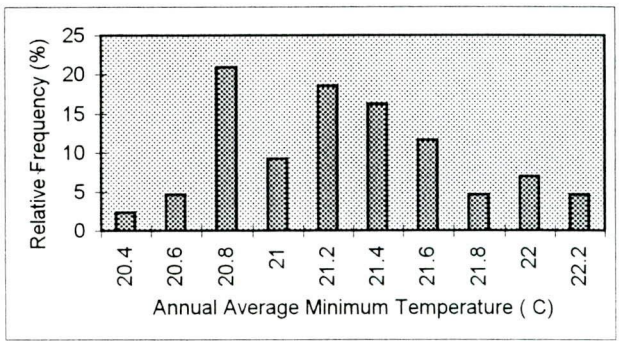


(h) Annual average rainfall

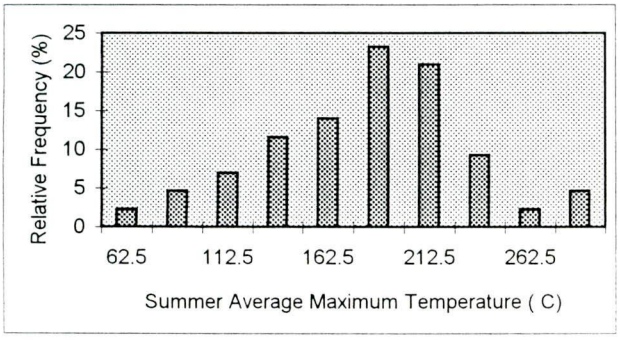
Figure 3.1 : Frequency histogram of different rainfall series of Dhaka city (1953-1995)



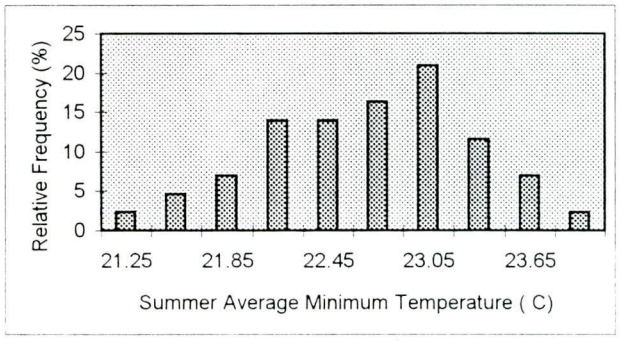
(a) Annual average maximum temperature



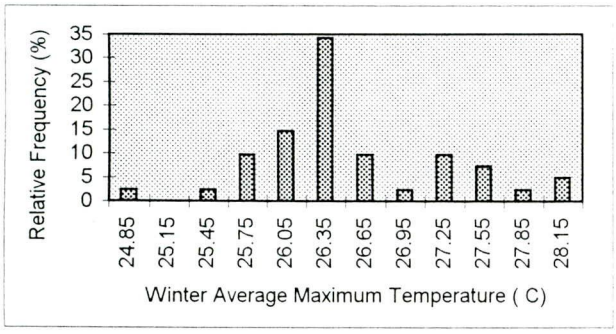
(b) Annual average minimum temperature



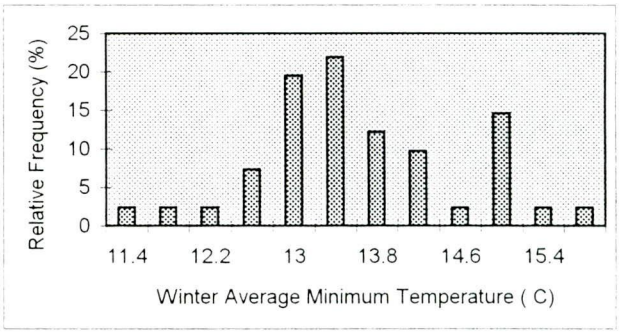
(c) Summer average maximum temperature



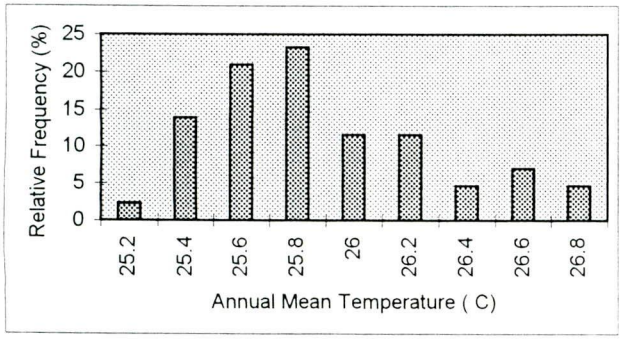
(d) Summer average minimum temperature



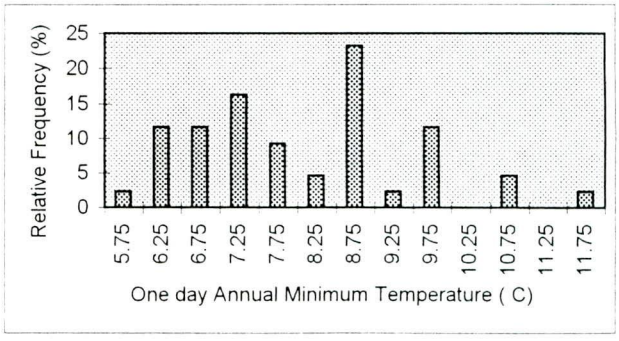
(e) Winter average maximum temperature



(f) Winter average minimum temperature

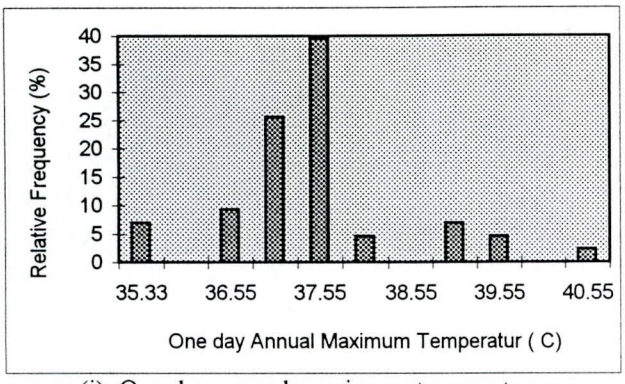


(g) Annual mean temperature



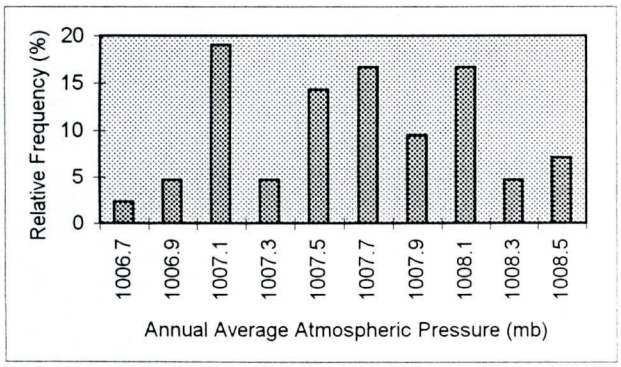
(h) One day annual minimum temperature

Figure 3.2 : Frequency histogram of different temperature series of Dhaka (1953-1995)



(i) One day annual maximum temperature

Figure 3.2 : Frequency histogram of different temperature series of Dhaka (1953-1995)



Annual average atmospheric pressure

Figure 3.3 : Frequency histogram of annual atmospheric pressure series of Dhaka (1953-1994)

Atmospheric Pressure histogram - - for annual data series for Dhaka city is presented in Figure 3.3 and frequency table is given in Table B.6 in Appendix-B. It is seen from this figure that frequency histogram of annual data series of atmospheric pressure appeared to be approximately normal.

Similarly, atmospheric pressure histogram of annual data series for Mymensingh is given in Figure C.4 in Appendix-C and frequency table is given in Table B.7 in Appendix-B. It is also seen from this figure that frequency histogram of annual data series of atmospheric pressure of Mymensingh appeared to be approximately normal.

Possible reasons for these large values of skewness may be of (1) measurement errors, in which case the high values may be disregarded, or (2) the high values may belong to a population different from that of the remaining sample values. In either case, variables that have symmetric frequency distribution except for a few large values, might be assumed to be approximately normal, particularly if the large values were excluded.

3.2.2 Skewness Test

Skewness is a measure of symmetry of the distribution and can be a conclusive indicator of non-normality. The skewness co-efficient, C_s is calculated by the following equation

$$C_s = \frac{\sum (x_i - \bar{x})^3}{S^3} \cdot \frac{n}{(n-1)(n-2)}$$

where, x_i = ith observation, $\bar{x}$ = mean of the observation and n = number of observations, and n / (n-1)(n-2) is a factor which make the value of C_s unbiased. Co-efficients of skewness of selected rainfall, temperature and atmospheric pressure data series are listed in Table 3.2.

Skewness of some of the data series have positive value and some have the negative value. Negative skewness is affected by a very few points which are very much lower than the rest. Based on skewness coefficient none of the rainfall, temperature and atmospheric pressure data series were found to be normal.

Table 3.2 : Skewness of rainfall, temperature and atmospheric pressure data series

Data Series	Skewness of the sample for the period		
	Dhaka (1953-1995)	Mymensingh (1951-1995)	Tangail (1962-1995)
a. Rainfall :			
Annual rainfall	0.16	0.35	0.61
Summer rainfall	0.33	0.81	-0.07
Monsoon rainfall	0.15	-0.02	0.75
One day annual max. rainfall	1.44	0.85	0.85
Annual average rainfall	0.15	0.35	0.6
Number of annual rainy days	-0.23	-0.07	-0.42
Number of Summer rainy days	0.31	0.19	0.09
Number of monsoon rainy days	0.17	-0.55	-0.49
b. Temperature :			
Annual average max. temp.	0.88	0.34	-
Annual average min. temp.	0.33	-0.38	-
Annual mean temp.	0.9	0.08	-
One day annual min. temp.	0.39	-1.12	-
One day annual max. temp.	0.55	-1.08	-
Summer average max. temp.	-0.06	-0.18	-
Summer average Min. temp.	-0.18	-0.79	-
Winter average max. temp.	0.49	0.07	-
Winter average min. temp.	-0.07	-0.46	-
C. Atmospheric Pressure :			
Annual average At. Pressure	0.03	-0.7	-

3.2.3 Chi-square Test

The Chi-square goodness-of-fit test is used to test for a significant difference between the distribution suggested by a data sample and a selected probability distribution. Here the test will assume the data have been drawn from a normal population and chi-square test will check the validity of the assumption. In essence the hypothesis being tested is :

H_0 : Samples drawn from population that are normally distributed.

H_1 : Samples drawn from population that are not normally distributed

The first step is to compute the χ^2 -statistic given by :

$$\chi^2 = \sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i}$$

in which O_i is the frequency of occurrence of values of the random variable within the range of cell i, E_i is the expected frequency of occurrence for the probability distribution specified in the null hypothesis, k is the number of cells; χ^2 is the value of a random variable that follows a chi-square distribution with k-q-1 degree of freedom, and q is the number of sample statistics used to compute the tabulated frequencies. The observed sample is used to form a histogram of k cells . For hydrologic application value of k should be between 10-25 and can have equal or unequal width. The observed frequencies for the range of values within each cell are determined from the sample. The expected frequencies are computed for the same cell configuration used to tabulate the observed frequencies. To compute the expected frequencies, the probability that is expected for each cell to be determined and multiplied by the sample size n. The expected probability for cell i, p_i, is the area under the population density function between the bounds for that cell. The sum of the expected frequencies must equal the sample size n.

The computed values of χ^2 are listed in Table 3.3 together with critical χ^2 for a significance level of 0.10 and an example calculation of χ^2 is also presented in Table B-8 in Appendix B.

Table 3.3 : Value of $\chi 2$ for rainfall, temperature and atmospheric pressure data series

Data Series	Station : Dhaka (1953-1995)			Station : Mymensingh (1951-1995)			Station : Tangail (1962-1995)		
	Comp. χ^2 value	d.o.f.	Crit. χ^2 at 10% sig. level	Comp. χ^2 value	d.o.f.	Crit. χ^2 at 10% sig. level	Comp. χ^2 value	d.o.f.	Crit. χ^2 at 10% sig. level
a. Rainfall :									
Annual rainfall	9.05	7	12.0	5.67	5	9.24	8.62	7	12.0
Summer rainfall	7.05	8	13.4	8.35	8	13.4	3.44	7	12.0
Monsoon rainfall	3.91	7	12.0	7.27	5	9.24	7.31	7	12.0
One day annual max. rainfall	35.77	8	13.4	20.54	7	12.0	.	8	13.4
Annual average rainfall	4.5	7	12.0	11.57	7	12.0	9.97	7	12.0
Number of annual rainy days	10.74	8	13.0	9.17	7	12.0	18.77	7	12.0
Number of summer rainy days	7.28	6	10.6	18.62	7	12.0	12.29	6	10.6
Number of monsoon rainy days	10.39	7	12.0	13.48	7	12.0	8.41	7	12.0
b. Temperature :									
Annual average max. temp.	20.04	8	13.4	4.74	6	10.6	-	-	-
Annual average min. temp.	8.88	7	12.0	7.28	5	9.24	-	--	-
Annual mean temp.	12.27	6	10.6	7.93	7	12.0	-	-	-
One day annual min. temp.	32.72	8	13.0	44.49	8	13.4	-	-	-
One day annual max. temp.	22.9	10	16.0	38.99	10	16.0	-		-
Summer average max. temp.	3.73	7	12.0	8.15	7	12.0	-	-	-
Summer average min. temp.	1.83	7	12.0	4.95	7	12.0	-	-	-
Winter average max. temp.	22.65	9	14.7	4.75	7	12.0	-	-	-
Winter average min. temp.	13.31	7	12.0	12.61	7	12.0	-	-	-
C. Atmospheric Pressure :									
Annual average At. Pressure	10.28	7	12.0	12.69	8	13.4	-	-	-

Based on χ^2-test, it can be concluded that those computed χ^2 value is smaller than the critical χ^2 value, these data series are normally distributed. Table 3.3 shows that the most of the data series appeared to be normal except one day annual maximum rainfall, annual average maximum temperature, annual mean temperature, one day annual maximum and

minimum temperature, winter average maximum and minimum temperature for Dhaka, one day annual maximum rainfall, number of summer and monsoon rainy days, one day annual maximum and minimum temperature and winter average minimum temperature for Mymensingh, and one day annual maximum rainfall, number of summer and annual rainy days for Tangail.

3.3 Estimation of Trend

Trends in a hydrometeorological time series can result from gradual natural or artificial changes in the hydrometeorological environment producing the time series. Urbanization on a large scale may result in changes in rainfall, temperature and pressure amounts that may show up as trends in respective data series. Detection of a trend of a time series in rainfall, temperature and atmospheric pressure were examined in three ways :

- Examination of time series plot
- Linear regression
- Moving average method

Rainfall, temperature and atmospheric pressure for Dhaka and Mymensingh were investigated to identify any trend and for Tangail, only rainfall data series was examined to identify any change.

3.3.1 Time Series Plot

A sequence of values collected over time on a particular variable is a time series. A time series may be composed of only deterministic events, only stochastic events or a combination of the two. Most generally a hydrometeorologic time series will be composed of a stochastic component superimposed on a deterministic component.

Rainfall - - time series data of annual rainfall, summer rainfall, monsoon rainfall and one day annual maximum rainfall for Dhaka city are plotted in Figures 3.11a, 3.12a, 3.13a and 3.14a, and data series are presented in Tables D.1 through D.4 in Appendix-D. Each of the data series of rainfall for Dhaka city exhibit year to year variation. Only summer rainfall showed a increasing tendency with large variability, and monsoon rainfall and one day annual maximum rainfall showed a decreasing tendency. Time series data of the, number of summer rainy days, number of monsoon rainy days and number of annual rainy days of Dhaka city are plotted in Figures 3.15a, 3.16a and 3.17a, and data series are given in Table D.5 in Appendix-D. The figures show that the number of summer rainy days has a increasing tendency but the number of monsoon rainy days shows a decreasing trend and

the number of annual rainy days of Dhaka does not show any increasing or decreasing trend.

Similar time series data of annual rainfall, summer rainfall, monsoon rainfall and one day annual maximum rainfall for Mymensingh are plotted in Figures 3.11b, 3.12b, 3.13b and 3.14b, and corresponding data tables are given in Tables D.6 through D.9 in Appendix-D. It is observed from the above figures that all the data series of rainfall for Mymensingh also exhibit year to year variability. It is also seen from the figures that each data series of rainfall in Mymensingh exhibits an increasing tendency. Time series data of the, number of summer rainy days, number of monsoon rainy days and number of annual rainy days for Mymensingh are also plotted in Figures 3.15b, 3.16b and 3.17b, and data series are given in Table D.10 in Appendix-D. Above figures reveal that each data series of number of rainy days for Mymensingh has an increasing trend.

For Tangail, data series of annual rainfall, summer rainfall, monsoon rainfall and one day annual maximum rainfall for Tangail are plotted in Figures 3.11c, 3.12c 3.13c and 3.14c, and corresponding data series are given in Tables D.11 to D.14 in Appendix-D. It is seen from the above figures that each data series of rainfall for Tangail showed the yearly variation and the data series of annual rainfall, summer rainfall, monsoon rainfall and one day annual maximum rainfall for Tangail has an increasing trend. Similarly, time series data of the number of summer rainy days and number of monsoon rainy days and number of annual rainy days for Tangail are plotted in Figure 3.15c, 3.16c and 3.17c, and data series are given in Table D.15 in Appendix-D. It is observed from these figures that number of rainy days in each data series for Tangail has an increasing trend throughout the period of record..

Temperature - - data series of temperature for Dhaka such as annual average maximum temperature, annual average minimum temperature, annual mean temperature, one day annual maximum temperature, one day annual minimum temperature are plotted in Figures 3.18(a, c), 3.19a and 3.20(a, c), and data series are given in Tables D.16 through D.20 in Appendix-D. These data series of temperature exhibit year to year variation, but showing a linearly increasing trend throughout the period in each data series. Similarly, seasonal data series of temperature for Dhaka are also plotted in Figures 3.21(a, c) and to 3.22(a, c), and data series are presented in Tables D.21 through D.24 in Appendix-D. It is seen from these figures that increasing tendency of temperature is occurred in summer average minimum temperature and winter average minimum temperature of Dhaka.

In the same way, different annual and seasonal data series of temperature such as annual average maximum temperature annual average minimum temperature, annual mean temperature, one day annual maximum temperature, one day annual minimum temperature, summer average maximum temperature, summer average minimum temperature, winter average maximum temperature and winter average minimum temperature for Mymensingh are also plotted in Figures 3.18(b, d), 3.19b, 3.20(b, d), 3.21(b, d) and 3.22(b, d), and data series are given in Tables D.25 to D.33 in Appendix-D. Each data series of temperature exhibits year to year variation. Only summer average maximum temperature, winter average maximum temperature and one day annual maximum temperature of Mymensingh exhibit a decreasing tendency of temperature.

Atmospheric Pressure - - time series data of annual average atmospheric pressure for Dhaka and Mymensingh are plotted in Figure 3.23 to examine the trend. Time series data are presented in Tables D.34 and D.35 in Appendix-D. It is observed from Figure 3.23 that year to year pressure variation is occurred throughout the period in Dhaka and Mymensingh. It is also seen that increasing trend of pressure is noticed only in case of Dhaka city.

3.3.2 Linear Regression

Long term trends may be identified by fitting a linear regression line to the data series of rainfall, temperature and atmospheric pressure. Trends are then identified by the slope of the respective regression lines. Linear regression line can be drawn by using the least square method. This method can also be used to find the mathematical equation of an appropriate trend line or trend curve. The least squares line approximating the set of points $(x_1, y_1), (x_2, y_2), \ldots \ldots \ldots (x_n, y_n)$ has the equation $y = a_0 + bx$.

where a_0 is the intercept and b is the slope of the regression line. Constant a_0 and b determined by solving simultaneously the equations

$$\Sigma y = a_0 N + b\Sigma x$$

$$\Sigma xy = a_0 \Sigma x + b \Sigma x^2$$

which are called the normal equations for the least squares line.

The constants are

$$a_0 = \frac{(\Sigma y)(\Sigma x^2) - (\Sigma x)(\Sigma xy)}{N\Sigma x^2 - (\Sigma x)^2}$$

$$b = \frac{N\Sigma xy - (\Sigma x)(\Sigma y)}{N\Sigma x^2 - (\Sigma x)^2}$$

Rainfall -- linear regression lines are fitted to the data series of annual rainfall, summer rainfall, monsoon rainfall and one day annual maximum rainfall for Dhaka city and linear regression lines are shown in Figures 3.11a, 3.12a, 3.13a and 3.14a. From these figures, it is seen that annual rainfall and summer rainfall have a increasing trend; but monsoon rainfall and one day annual maximum rainfall of Dhaka have a decreasing trend. Linear regression lines have also been drawn for the data series of the number of summer rainy days, number of monsoon rainy days and number of annual rainy days for Dhaka city and presented in Figures 3.15a, 3.16a and 3.17a. It is observed from these figures that number of summer rainy days has a increasing trend, but the number of monsoon rainy days has a decreasing trend, and no increasing or decreasing trend is found in the number of annual rainy days.

Similar linear regression lines are fitted to the data series of annual rainfall, summer rainfall, monsoon rainfall and one day annual maximum rainfall for Mymensingh and linear regression lines are shown in Figure 3.11b, 3.12b, 3.13b and 3.14b. It is seen from these figures that above data series have an increasing trend. In the same way, linear regression lines have also been drawn for the data series of the number of summer rainy days, number of monsoon rainy days and number of annual rainy days for Mymensingh and presented in Figures 3.15b, 3.16b and 3.17b. It is seen from the figures that each data series has an increasing trend.

For Tangail, linear regression lines are fitted to the data series of annual rainfall, summer rainfall, monsoon rainfall and one day annual maximum rainfall are shown in Figures 3.11c, 3.12c, 3.13c and 3.14c. From the above figures, it is observed that above data series of rainfall for Tangail has an increasing trend. Also linear regression lines have been drawn for the data series of the number of annual rainy days, number of summer rainy days and number of monsoon rainy days are presented in Figures 3.15c, 3.16c and 3.17c. It is observed from these figures that in each data series of the number of rainy days of Tangail has an increasing trend.

The statistical significance of the observed trends in the above rainfall data series for Dhaka city, Mymensingh and Tangail are judged by t-test and results are presented in Section 3.3.2.1

Temperature - - time series data of annual average maximum temperature, annual average minimum temperature, annual mean temperature, one day annual maximum temperature, one day annual minimum temperature, summer average maximum temperature, summer average minimum temperature, winter average maximum temperature, winter average minimum temperature for Dhaka city were used to compute the linear trend by using linear regression line and are presented in Figures 3.18(a, c), 3.19a, 3.20(a, c), 3.21(a, c) and 3.22(a, c). It is observed from these figures that each data series of temperature for Dhaka has an increasing trend. Increasing rate of temperature is higher for the case of annual average maximum temperature, annual average minimum temperature, annual mean temperature, one day annual maximum temperature, one day annual minimum temperature and winter average minimum temperature for Dhaka.

For Mymensingh, similar linear regression lines are also fitted to the data series of annual average maximum temperature, annual average minimum temperature, annual mean temperature, one day annual maximum temperature, one day annual minimum temperature, summer average maximum temperature, summer average minimum temperature, winter average maximum temperature, winter average minimum temperature and are presented in Figures 3.18(b, d), 3.19(b, d), 3.20(b, d), 3.21(b, d) and 3.22(b, d). It is observed from these figures that each data series of temperature has a decreasing trend except annual average minimum temperature, summer average minimum temperature and winter average minimum temperature; these three data series of minimum temperature for Mymensingh showed a small increasing trend. Decreasing rate of temperature is higher in one day annual maximum temperature and summer average maximum temperature than other data series of temperature for Mymensingh.

The statistical significance of the observed trends in the above temperature data series for Dhaka city and Mymensingh are judged by t-test and results are presented in Section 3.3.2.1.

Atmospheric Pressure -- linear regression lines are fitted to the data series of annual average atmospheric pressure for Dhaka city and Mymensingh and presented in Figures 3.23a and 3.23b. It is seen from these figures that the data series of atmospheric pressure for Dhaka and Mymensingh has an increasing trend. But, rate of increasing of pressure is lower in Mymensingh and higher in Dhaka.

The statistical significance of the observed trends in the above atmospheric pressure data series for Dhaka city and Mymensingh are judged by t-test and results are presented in Section 3.3.2.1.

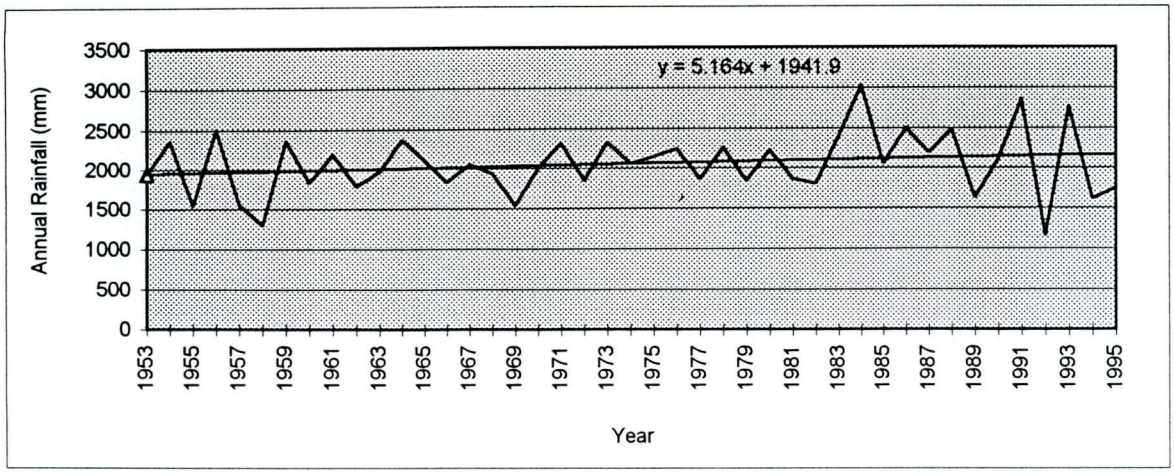


Fig.a : Trend of annual rainfall in Dhaka for 43 years (1953-1995)

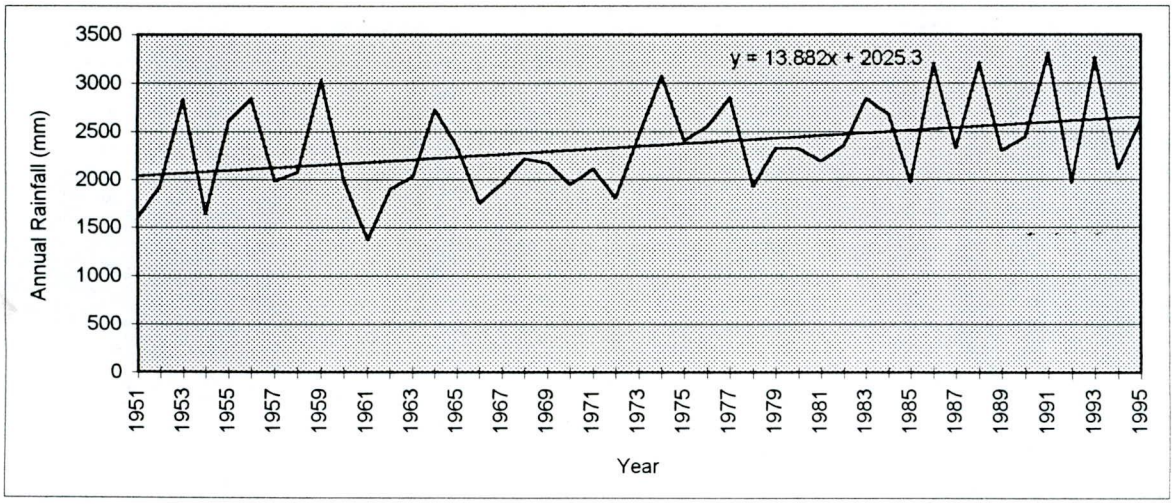


Fig.b : Trend of annual rainfall in Mymensingh for 45 years (1951-1995)

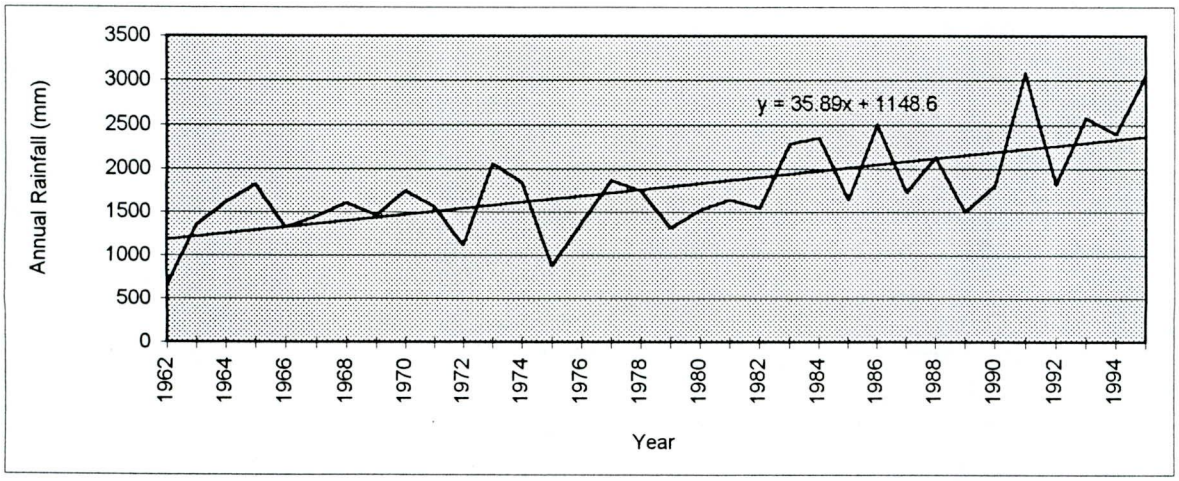


Fig.c : Trend of annual rainfall in Tangail for 34 years (1962-1995)

Fig. 3.11 : Trend of Annual Rainfall for Dhaka (1953-1995), Mymensingh (1951-1995) & Tangail (1962-1995)

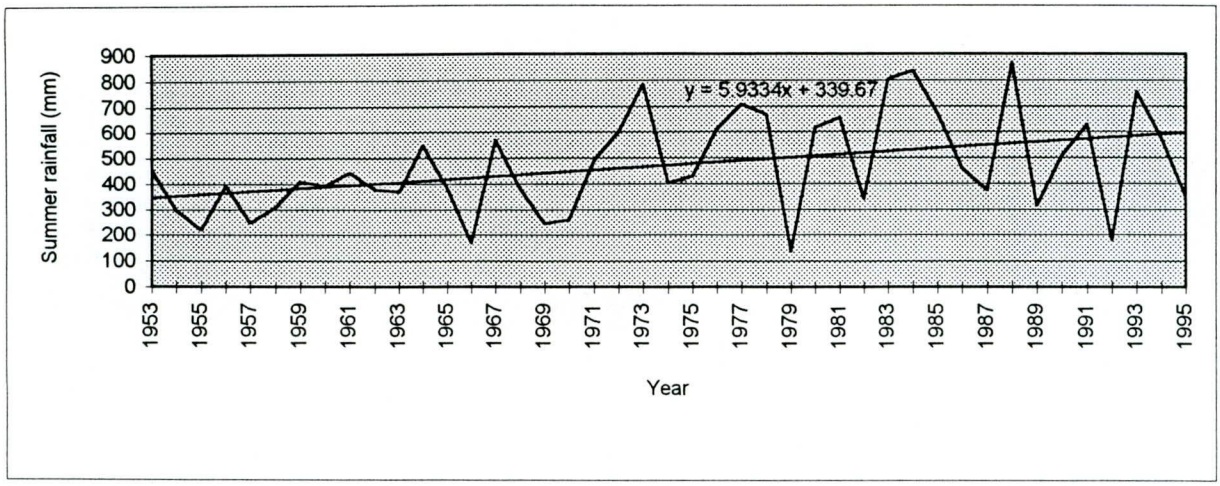


Fig.a : Trend of Summer rainfall in Dhaka for 43 years (1953-1995)

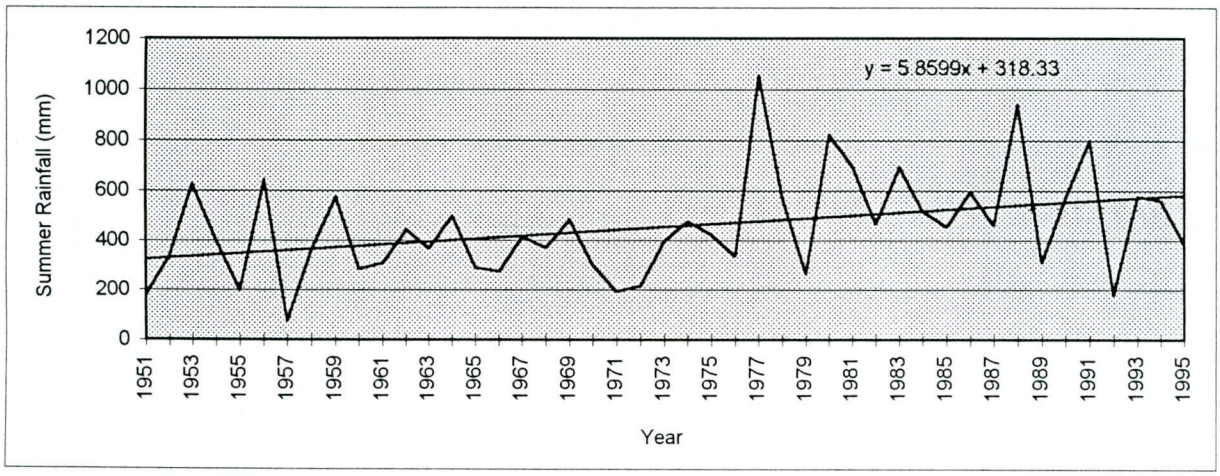


Fig.b : Trend of Summer rainfall in Mymensingh for 45 years (1951-1995)

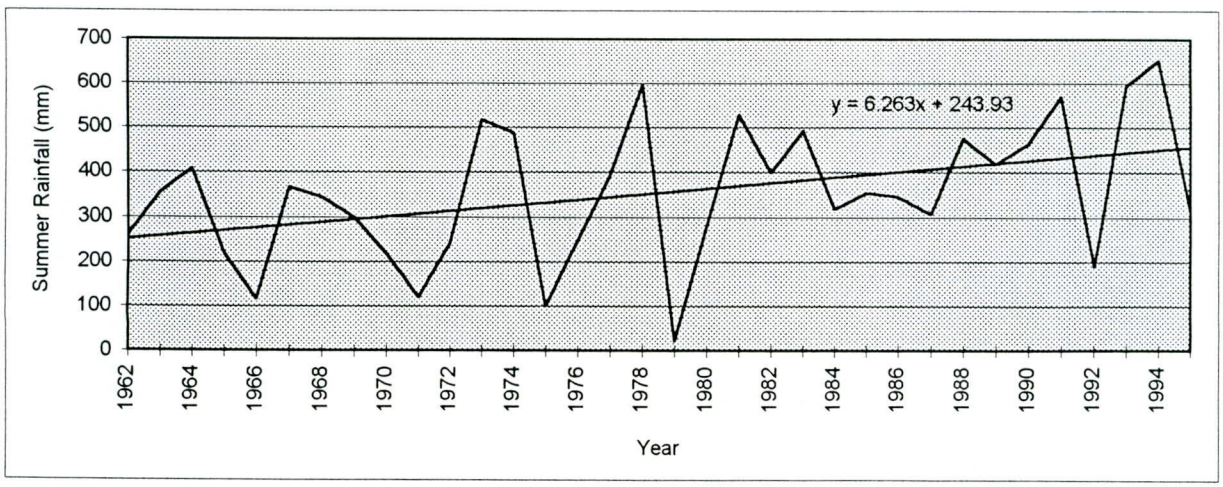


Fig.c : Trend of Summer rainfall in Tangail for 34 years (1962-1995)

Fig. 3.12 : Trend of Summer Rainfall for Dhaka (1953-1995), Mymensingh (1951-1995) & Tangail (1962-1995)

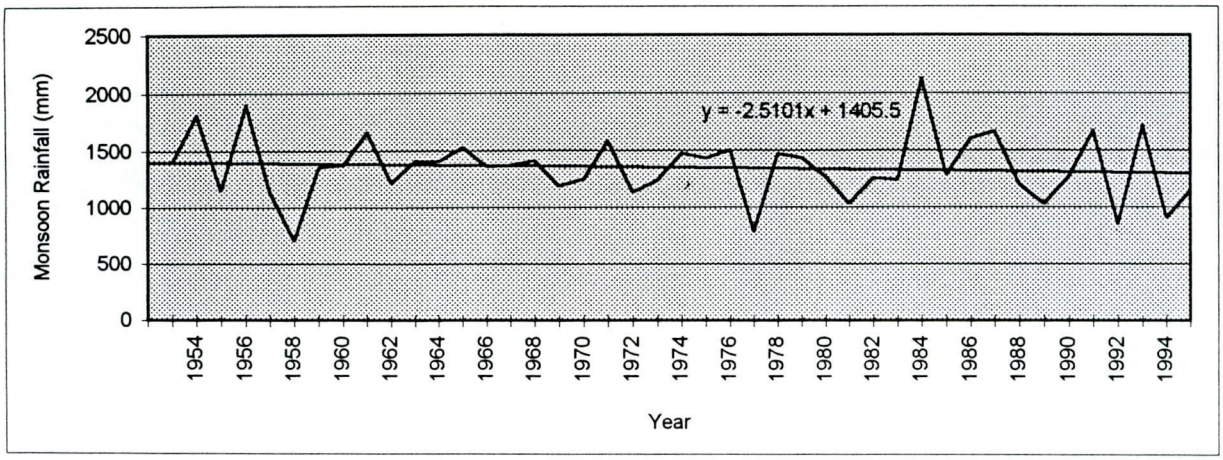


Fig.a : Trend of monsoon rainfall in Dhaka for 43 years (1953-1995)

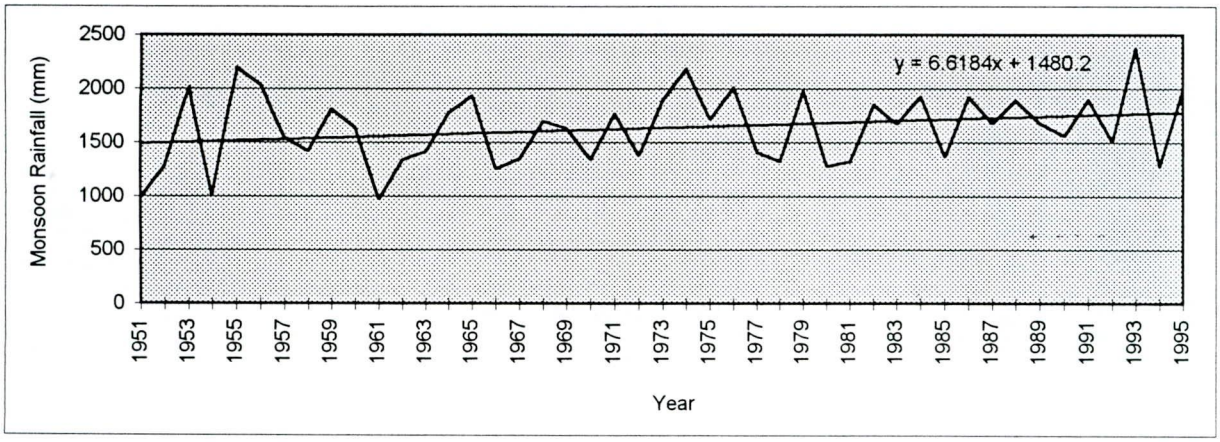


Fig.b : Trend of monsoon rainfall in Mymensingh for 45 years (1951-1995)

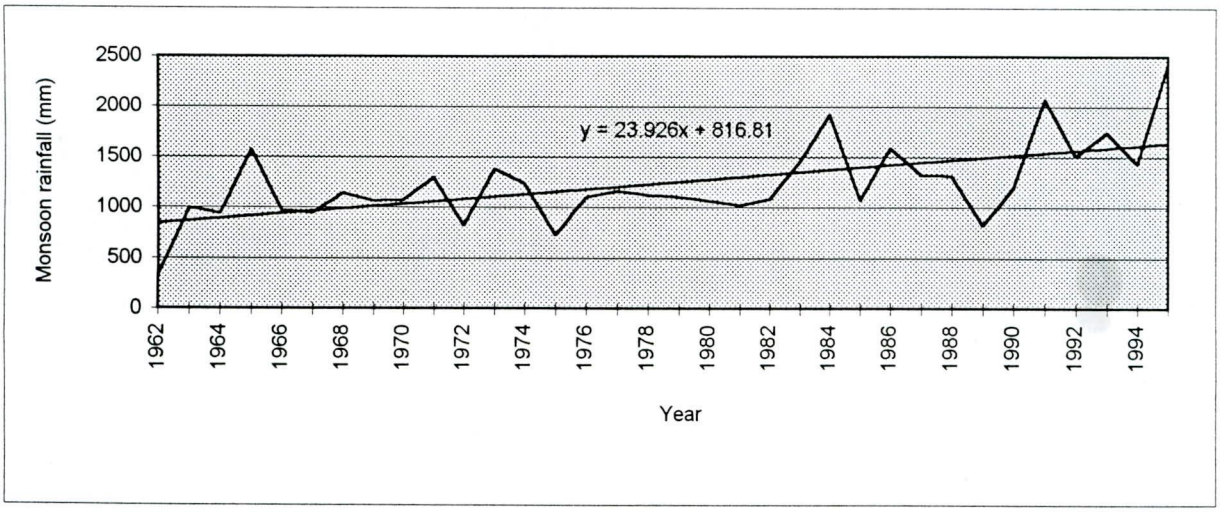


Fig.c : Trend of monsoon rainfall in Tangail for 34 years (1962-1995)

Fig. 3.13 : Trend of Monsoon Rainfall for Dhaka (1953-1995), Mymensingh (1951-1995) & Tangail (1962-1995)

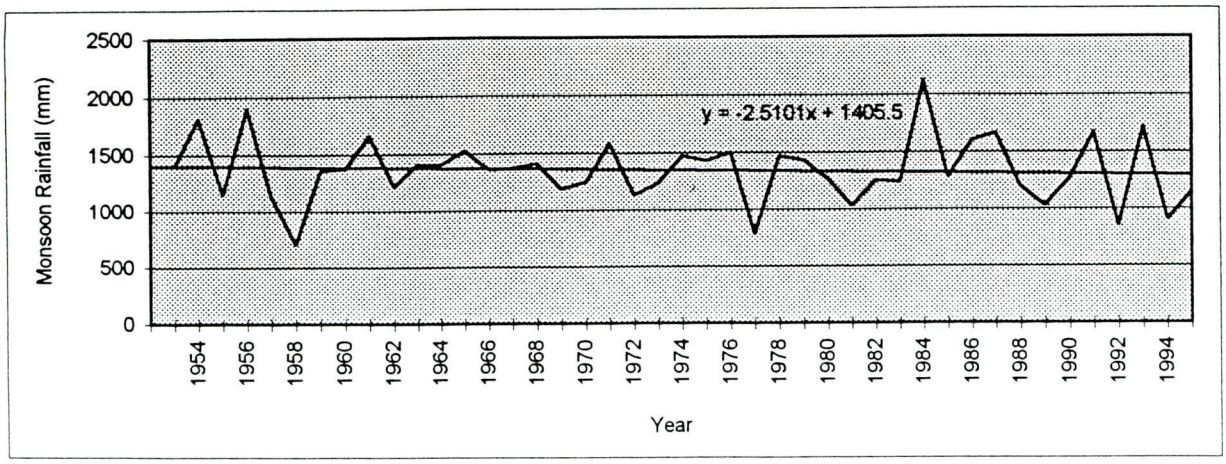


Fig.a : Trend of monsoon rainfall in Dhaka for 43 years (1953-1995)

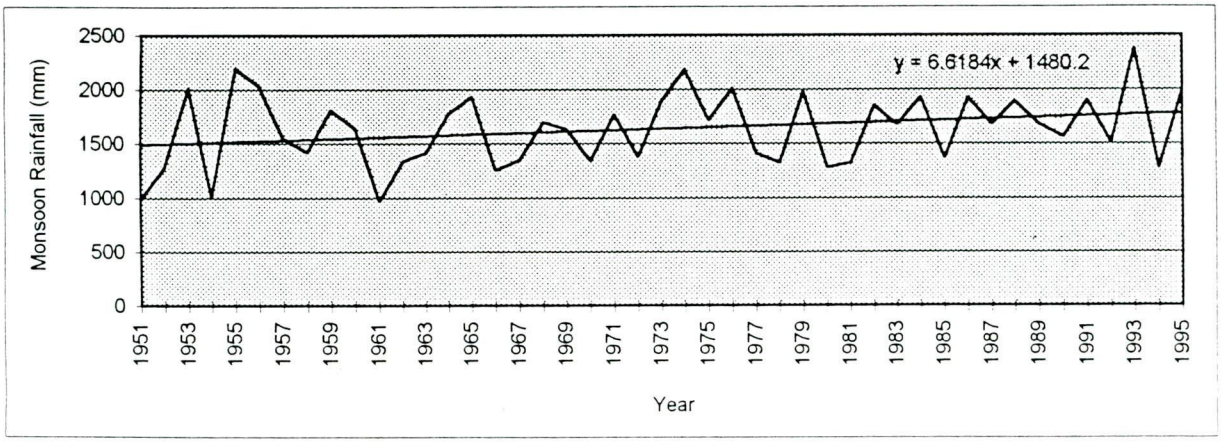


Fig.b : Trend of monsoon rainfall in Mymensingh for 45 years (1951-1995)

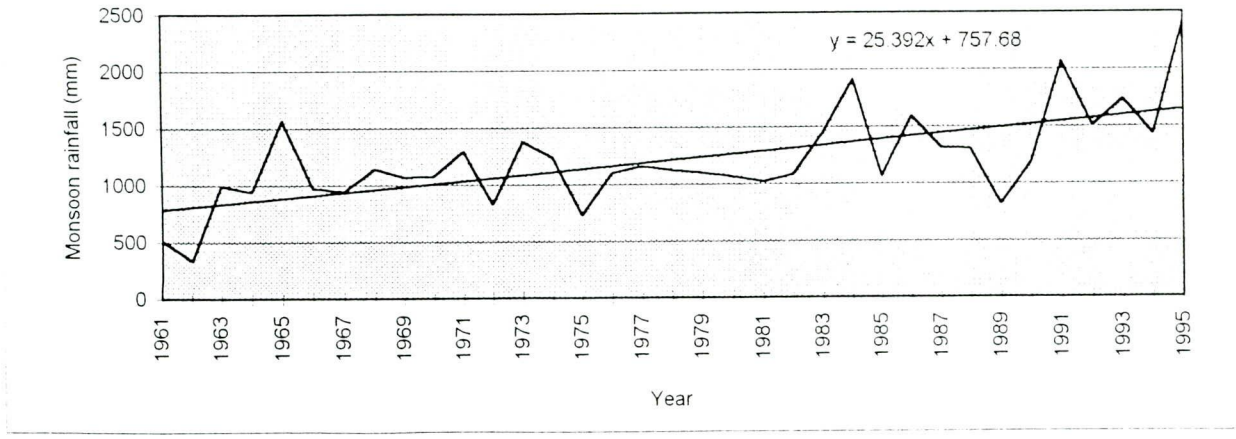


Figure (c) : Trend of monsoon rainfall in Tangail for 35 years period (1961-1995)

Fig. 3.13 : Trend of Monsoon Rainfall for Dhaka (1953-1995), Mymensingh (1951-1995) & Tangail (1962-1995)

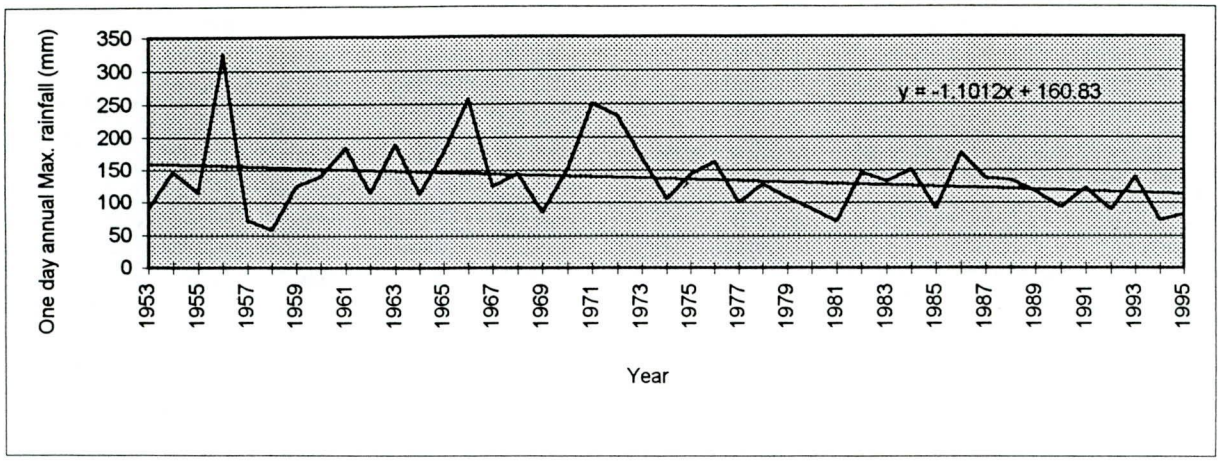


Fig.a : Trend of oneday annual maximum rainfall in Dhaka for 43 years (1953-1995)

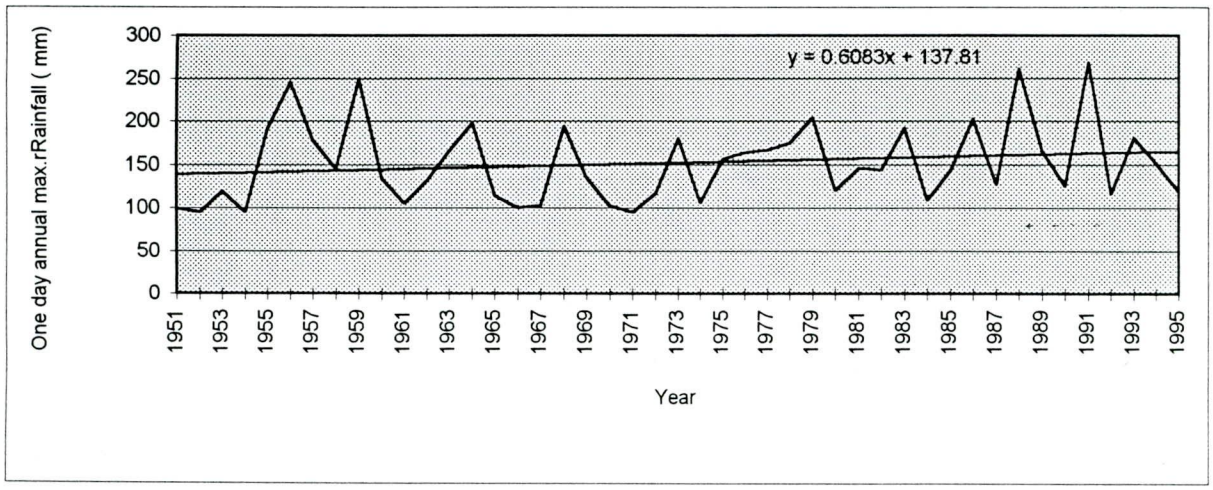


Fig.b : Trend of oneday annual maximum rainfall in Mymensingh for 45 years (1951-1995)

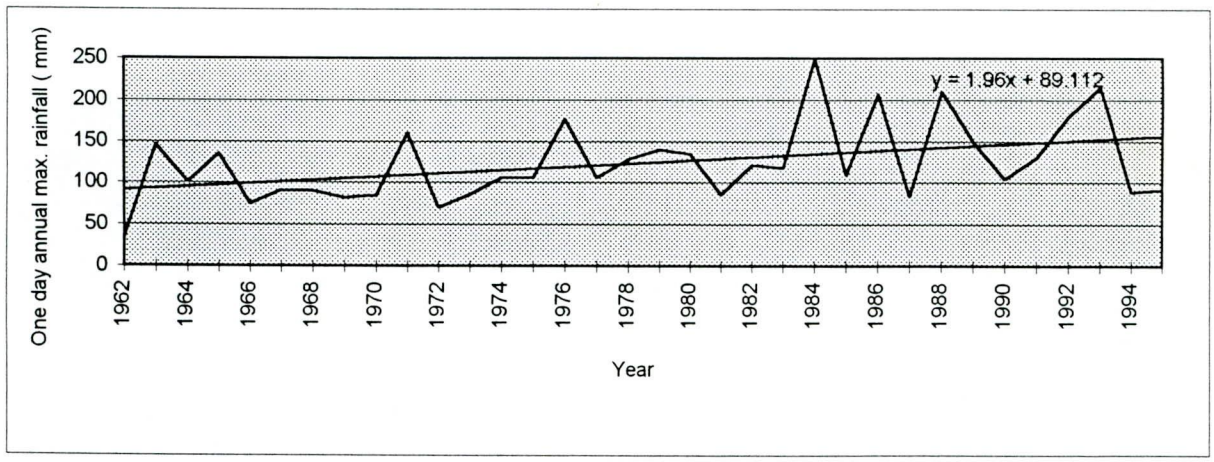


Fig.c : Trend of oneday annual maximum rainfall in Tangail for 34 years (1962-1995)

Fig. 3.14 : Trend of Oneday Annual Maximum Rainfall for Dhaka (1953-1995), . Mymensingh (1951-1995) & Tangail (1962-1995)

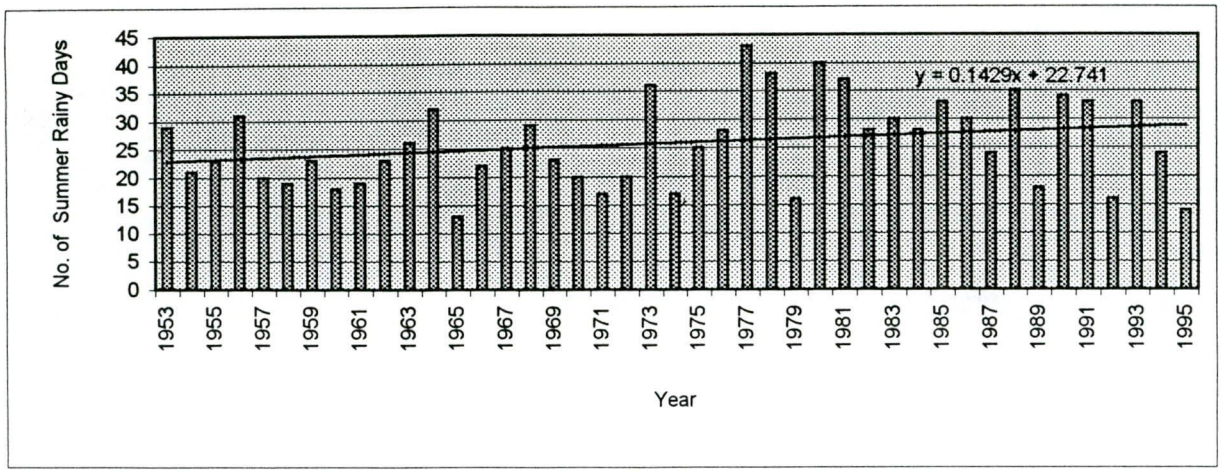


Fig.a : Trend of number of Summer rainy days in Dhaka for 43 years (1953-1995)

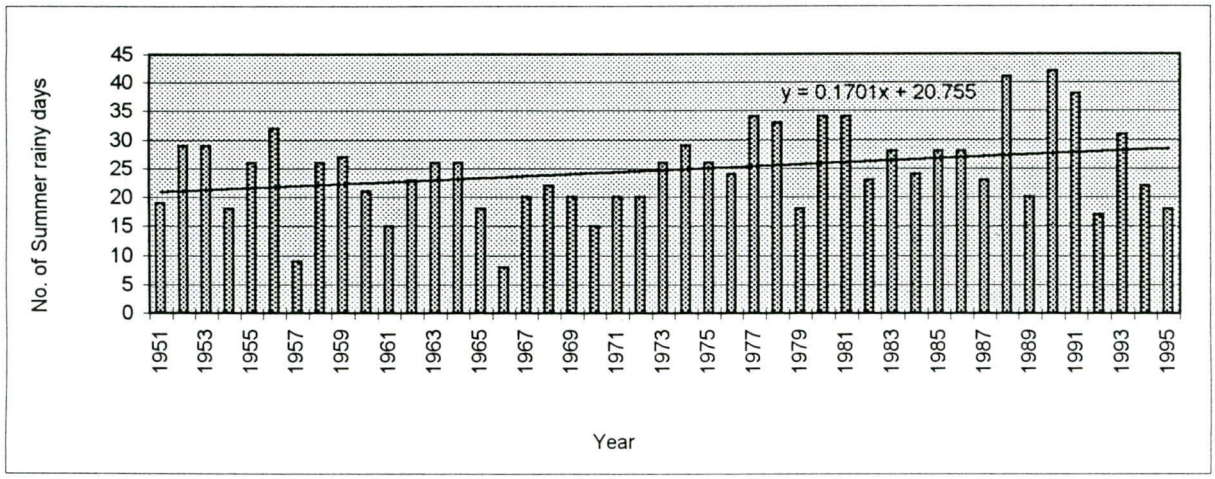


Fig.b : Trend of number of Summer rainy days in Mymensing for 45 years (1951-1995)

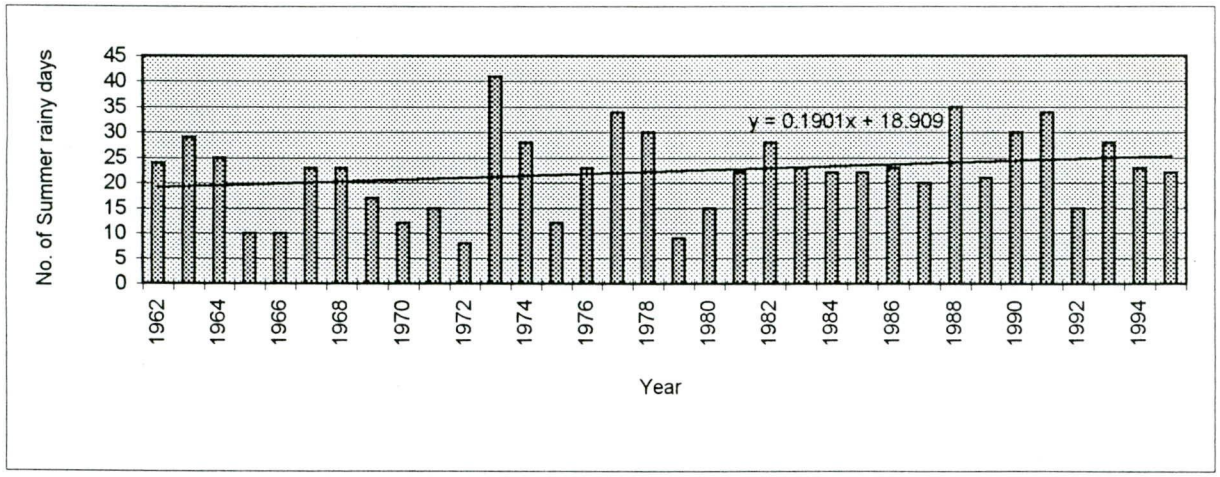


Fig.c : Trend of number of Summer rainy days in Tangail for 34 years (1962-1995)

Fig. 3.15 : Trend of number of Summer Rainy Days for Dhaka (1953-1995), Mymensingh (1951-1995) & Tangail (1962-1995)

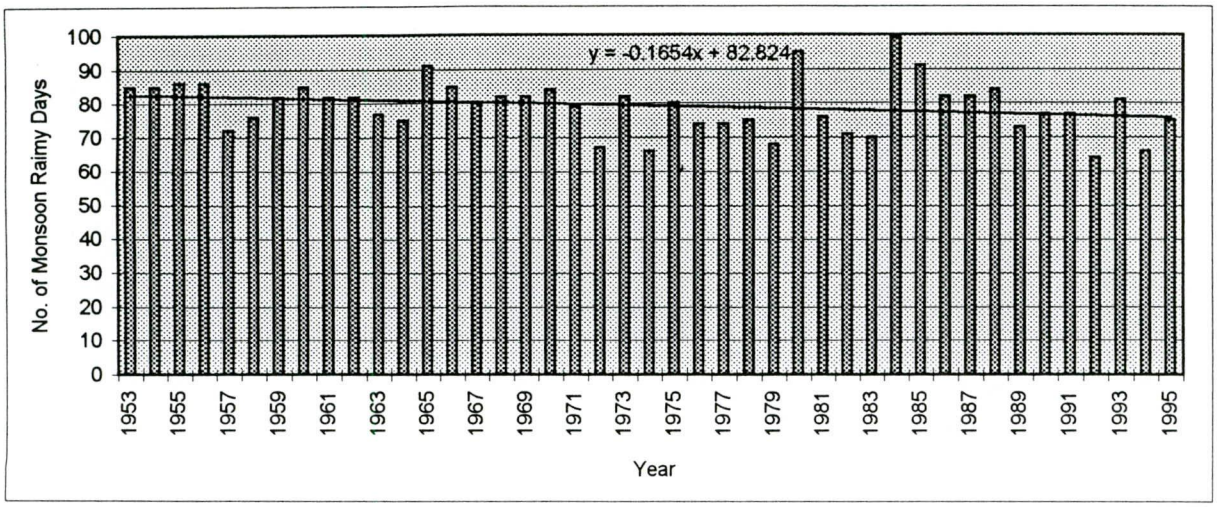


Fig.a : Trend of number of monsoon rainy days in Dhaka for 43 years (1953-1995)

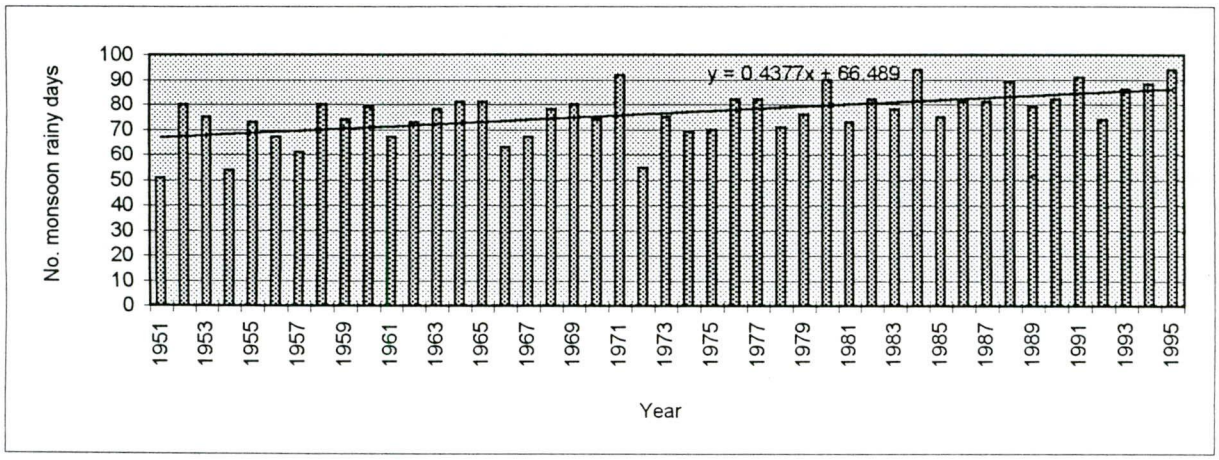


Fig.b : Trend of number of monsoon rainy days in Mymensingh for 45 years (1951-1995)

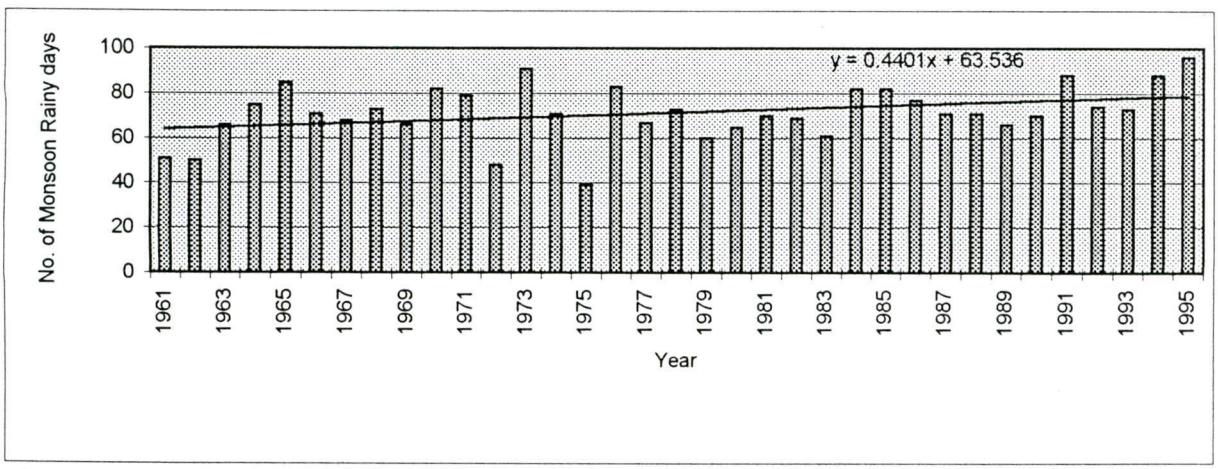


Fig.c : Trend of number of monsoon rainy days in Tangail for 35 years (1961-1995)

Fig. 3.16 : Trend of number of Monsoon Rainy Days for Dhaka (1953-1995), Mymensingh (1951-1995) & Tangail (1962-1995)

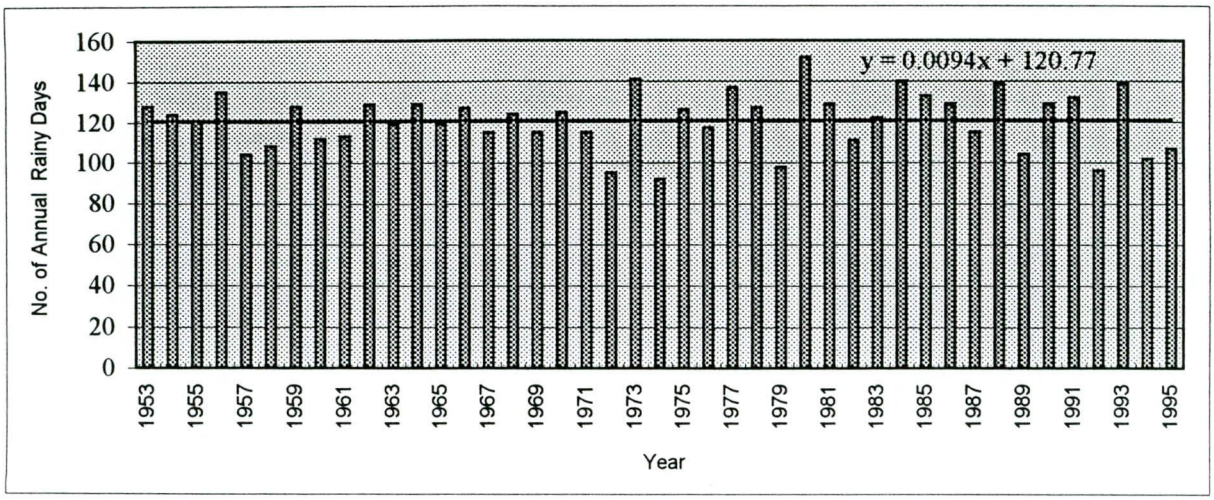


Fig.a : Trend of number of annual rainy days in Dhaka for 43 years (1953-1995)

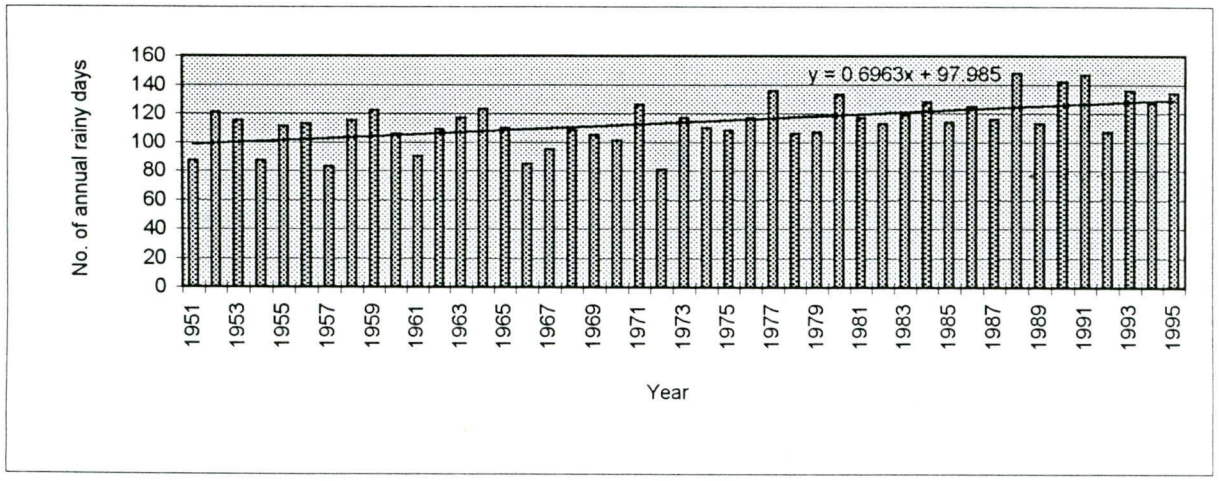


Fig.b : Trend of number of annual rainy days in Mymensingh for 45 years (1951-1995)

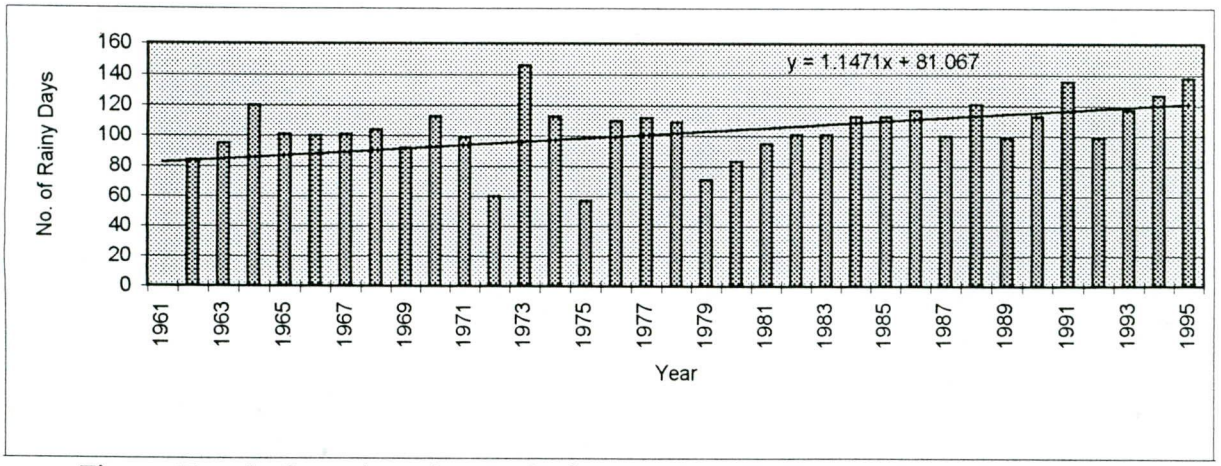


Fig.c : Trend of number of annual rainy days in Tangail for 34 years (1962-1995)

Fig. 3.17 : Trend of number of Annual Rainy Days for Dhaka (1953-1995), Mymensingh (1951-1995) & Tangail (1962-1995)

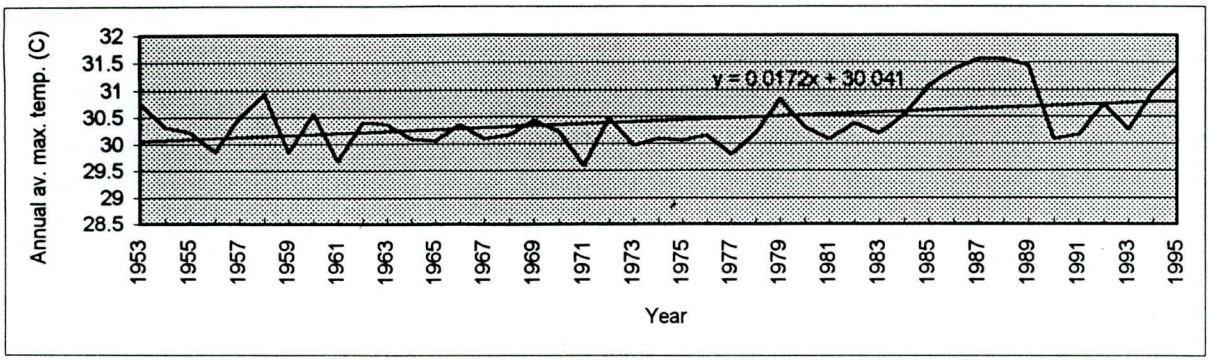


Fig. a : Trend of Annual Average Maximum Temperature in Dhaka for 43 years (1953-1995)

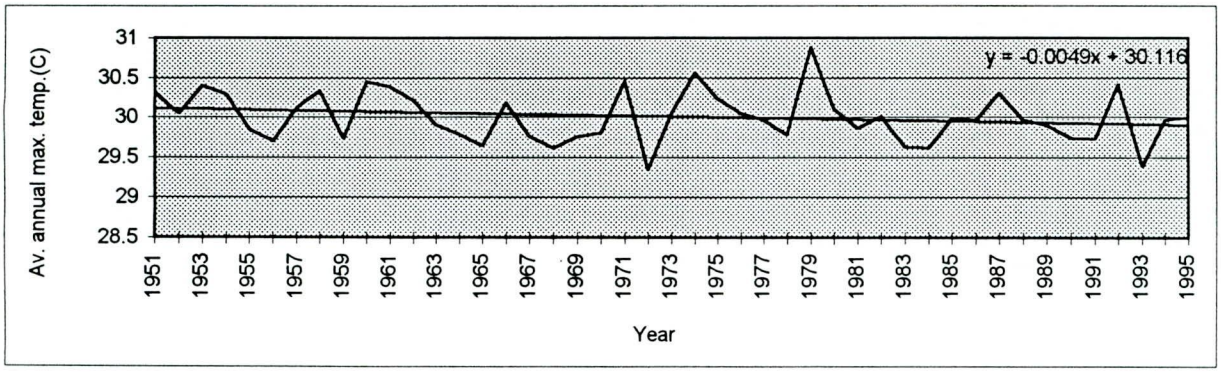


Fig. b : Trend of Annual Average Maximum Temperature in Mymensingh for 45 years (1951-1995)

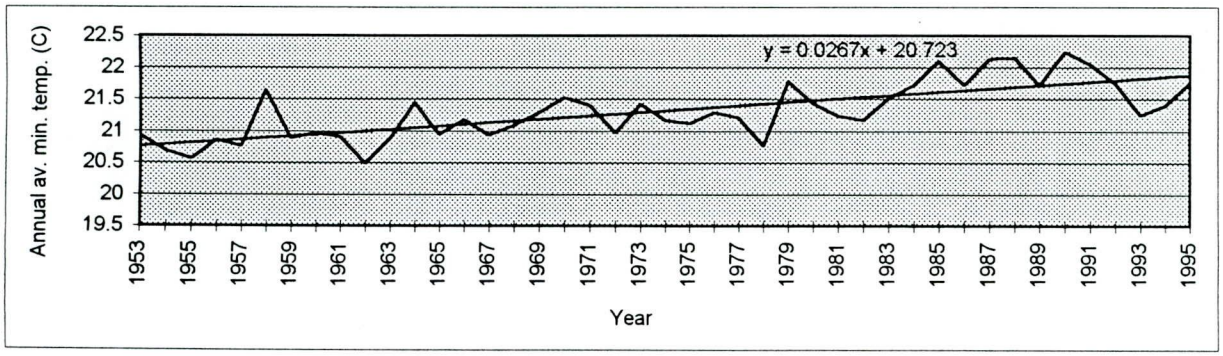


Fig. c : Trend of Annual Average Minimum Temperature in Dhaka for 43 years (1953-1995)

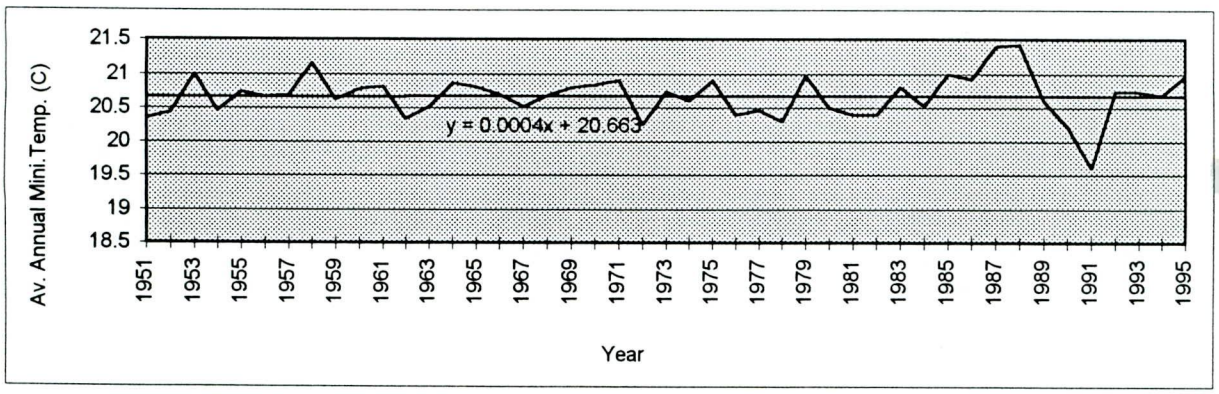


Fig. d : Trend of Annual Average Minimum Temperature in Mymensingh for 45 years (1951-1995)

Figure 3.18 : Trend of Annual Average Maximum & Minimum Temperature for Dhaka (1953-1995) & Mymensingh (1951-1995)

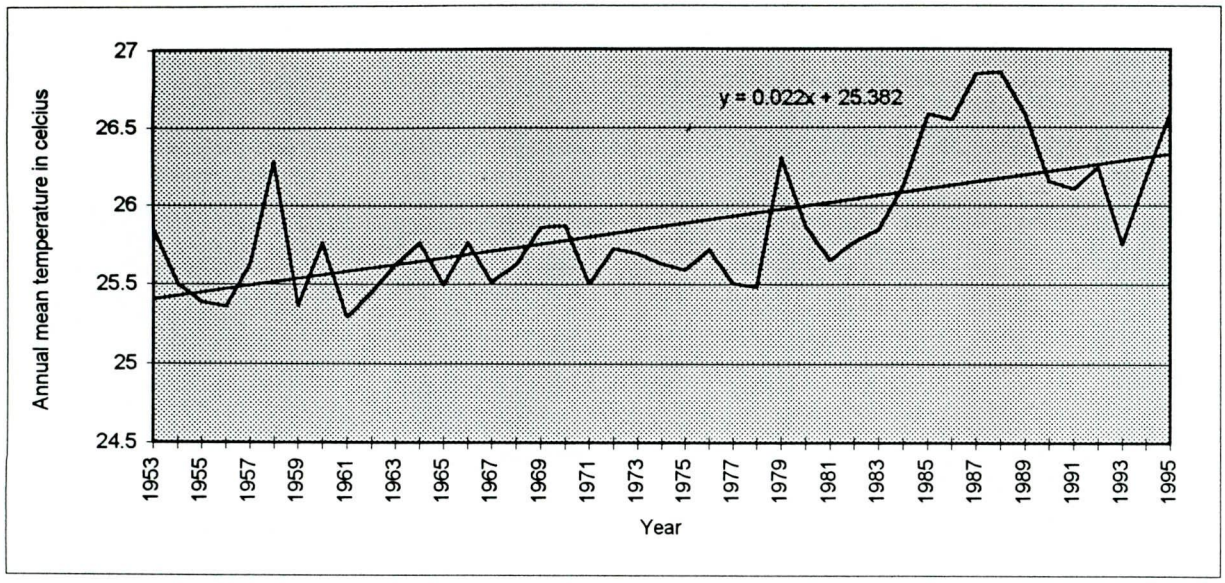


Fig. a : Trend of Annual Mean Temperature in Dhaka for 43 years (1953-1995)

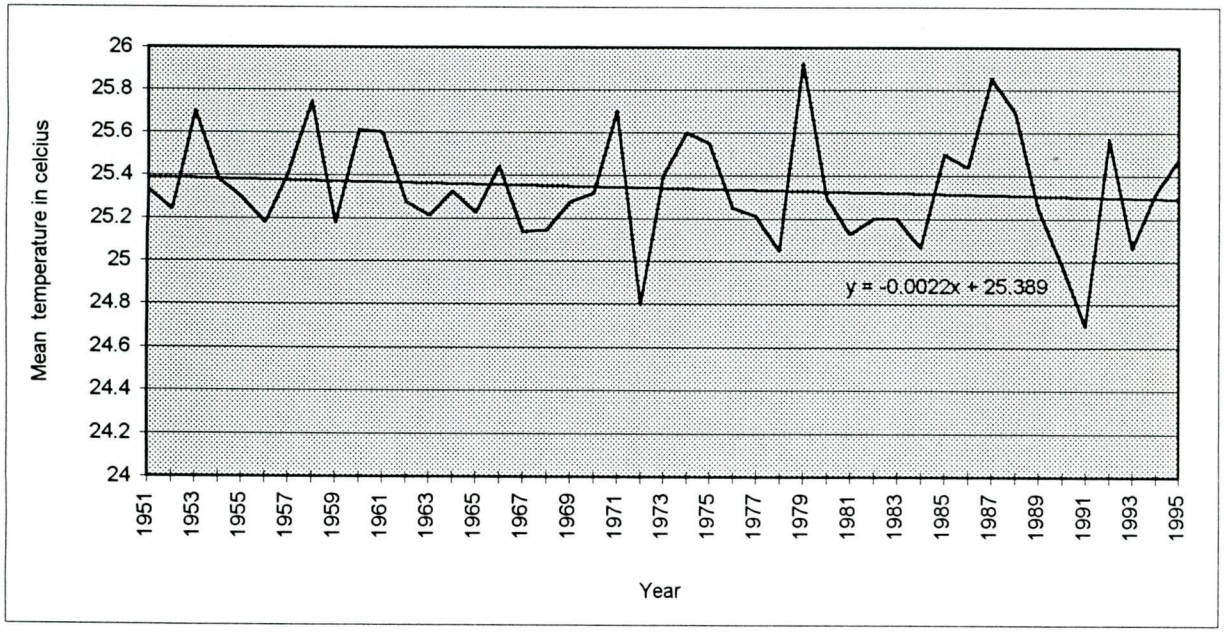


Fig. d : Trend of Annual Mean Temperature in Mymensingh for 45 years (1951-1995)

Fig. 3.19 : Trend of Annual Mean Temperature for Dhaka (1953-1995) & Mymensingh (1951-1995)

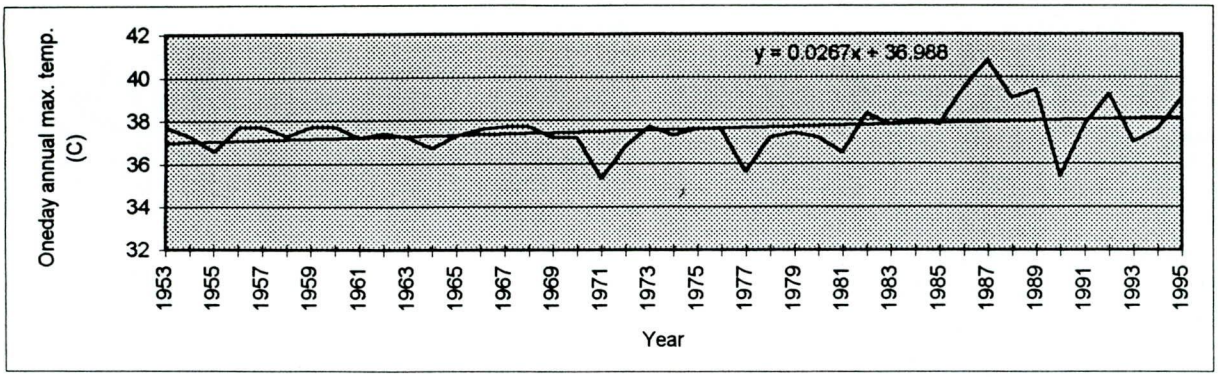


Fig. a : Oneday Annual Maximum Temperature in Dhaka for 43 years (1953-1995)

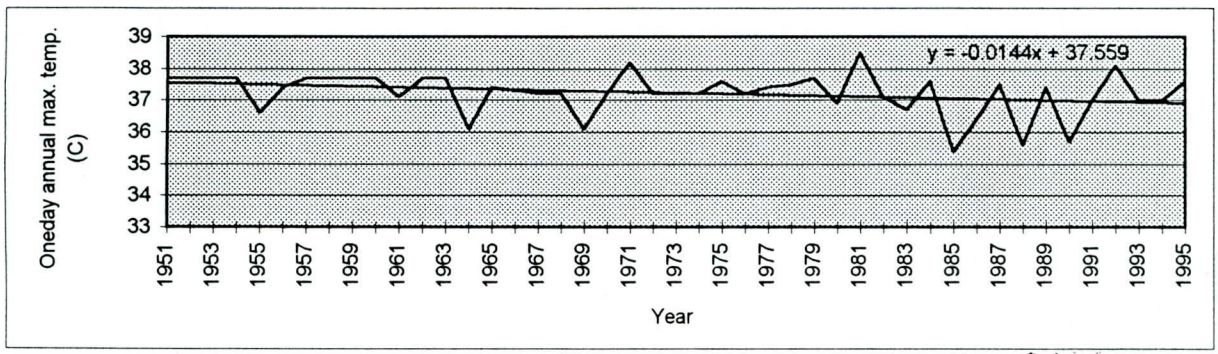


Fig. b : Oneday Annual Maximum Temperature in Mymensingh for 45 years (1951-1995)

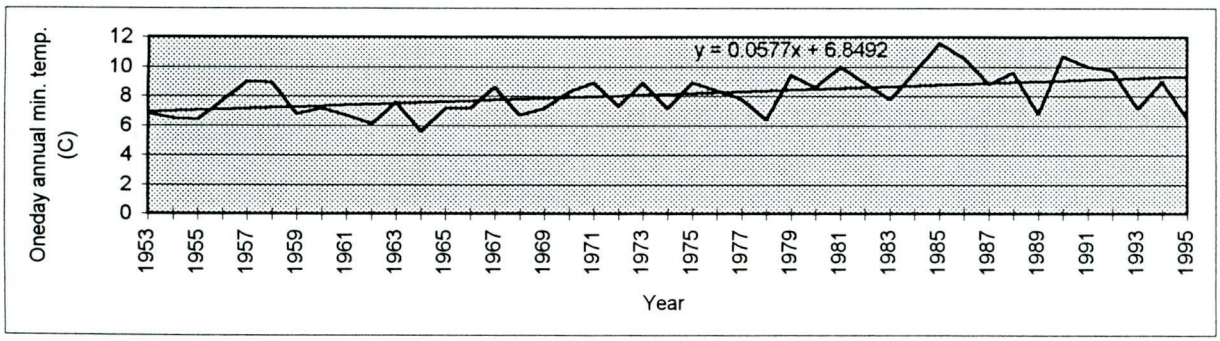


Fig. c : Oneday Annual Minimum Temperature in Dhaka for 43 years (1953-1995)

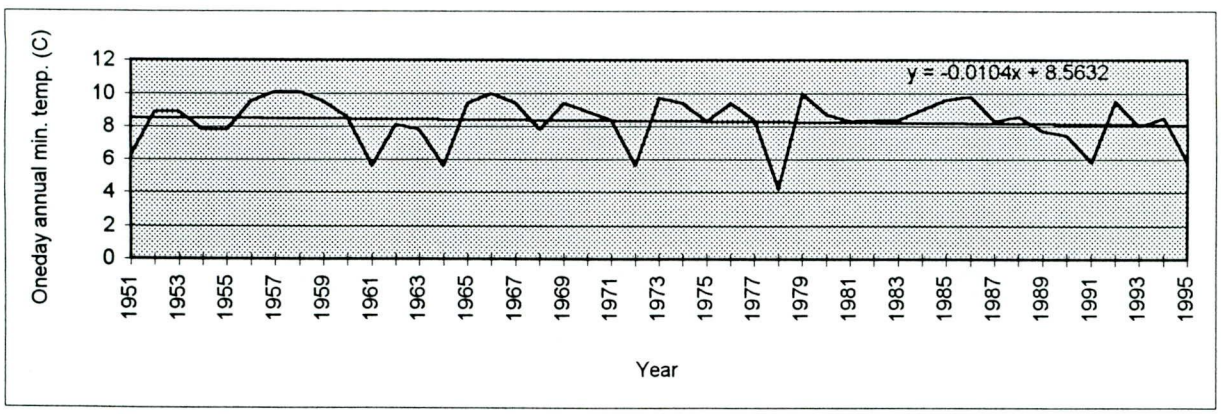


Fig. d : Oneday Annual Minimum Temperature in Mymensingh for 45 years (1951-1995)

Fig. 3.20 : Trend of Oneday Annual Maximum & Minimum Temperature for Dhaka (1953-1995) & Mymensingh (1951-1995)

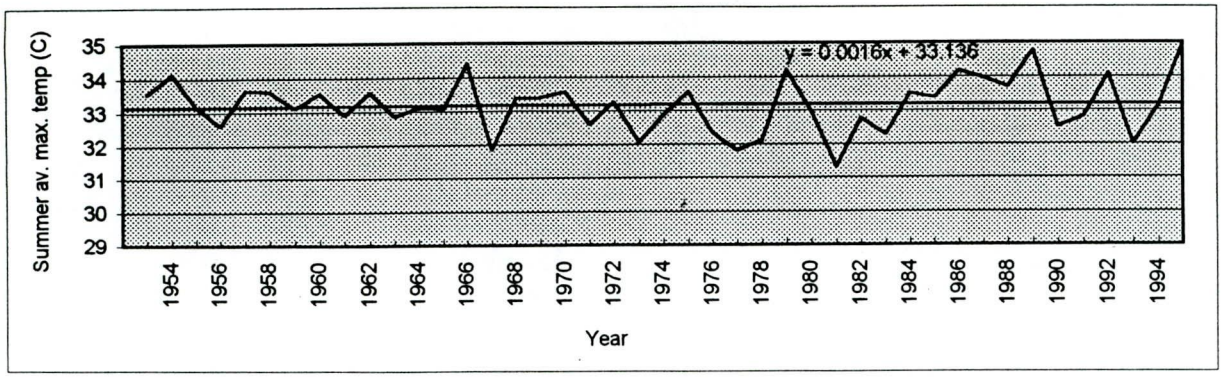


Fig. a : Trend of Summer Average Maximum Temperature in Dhaka for 43 years (1953-1995)

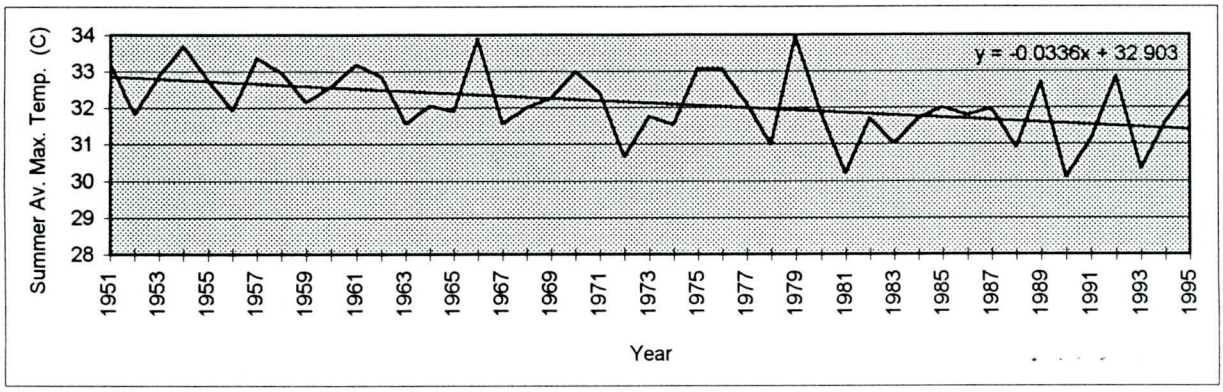


Fig. b : Trend of Summer Average Maximum Temperature in Mymensingh for 45 years (1951-1995)

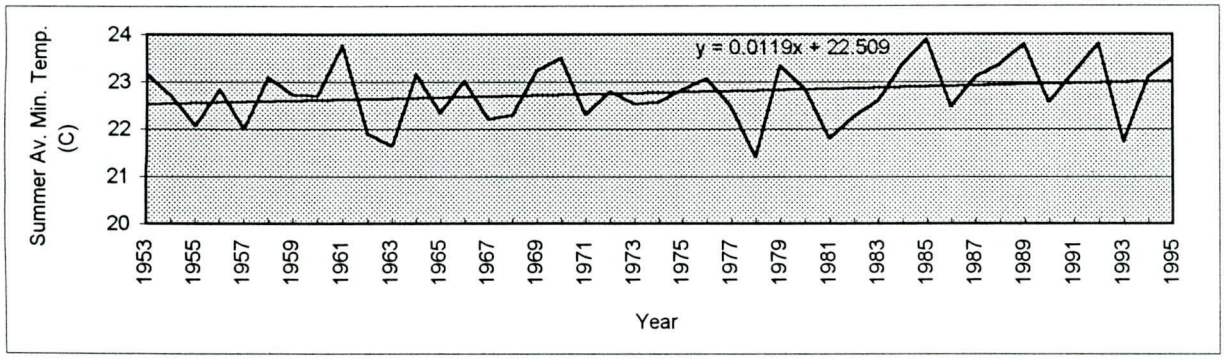


Fig. c : Trend of Summer Average Minimum Temperature in Dhaka for 43 years (1953-1995)

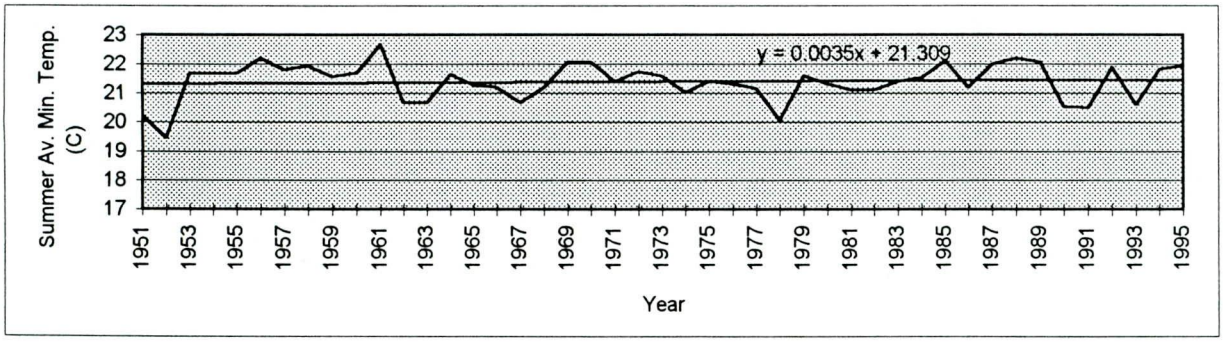


Fig. d : Trend of Summer Average Minimum Temperature in Mymensingh for 45 years (1951-1995)

Figure 3.21 : Trend of Summer Average Maximum & Minimum Temperature for Dhaka (1953-1995) & Mymensingh (1951-1995)

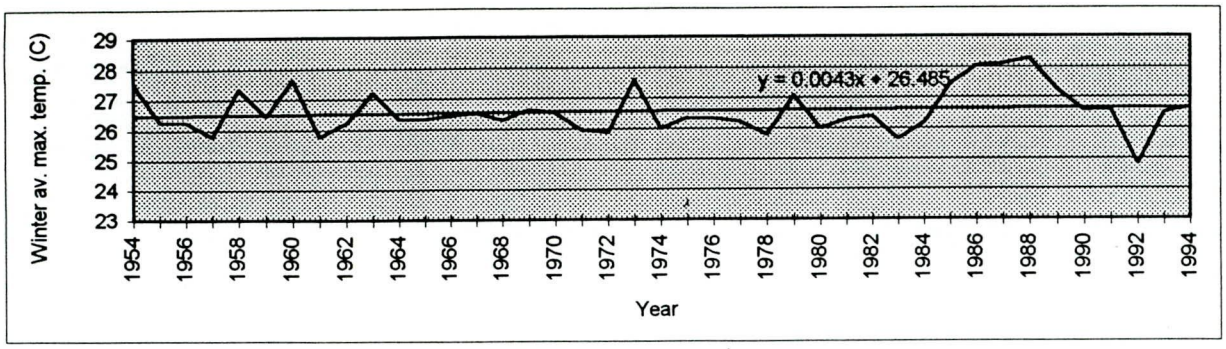


Fig. a : Trend of Winter Average Maximum Temperature in Dhaka for 41 years (1954-1994)

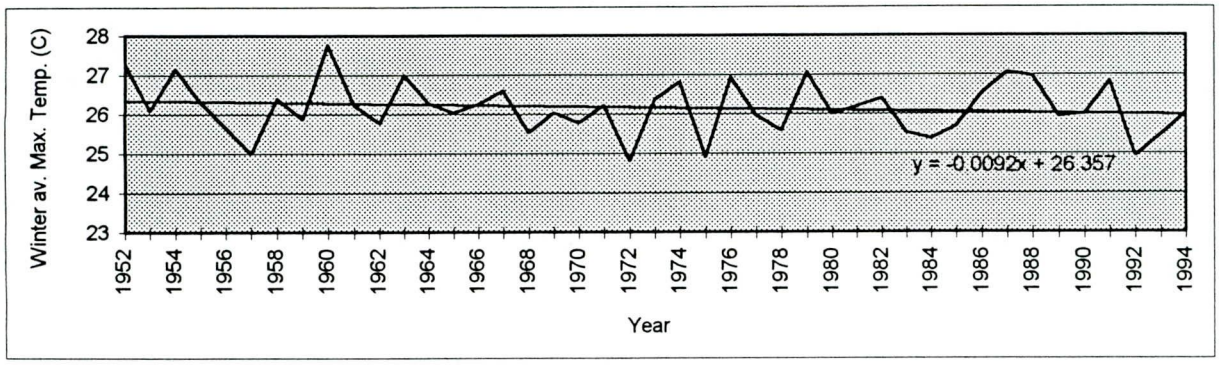


Fig. b : Trend of Winter Average Maximum Temperature in Mymensingh for 43 years (1952-1994)

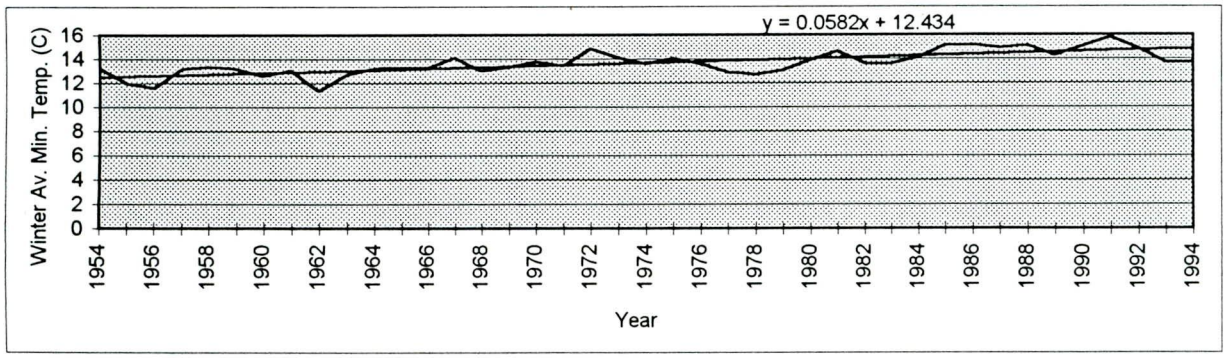


Fig. c : Trend of Winter Average Minimum Temperature in Dhaka for 41 years (1954-1994)

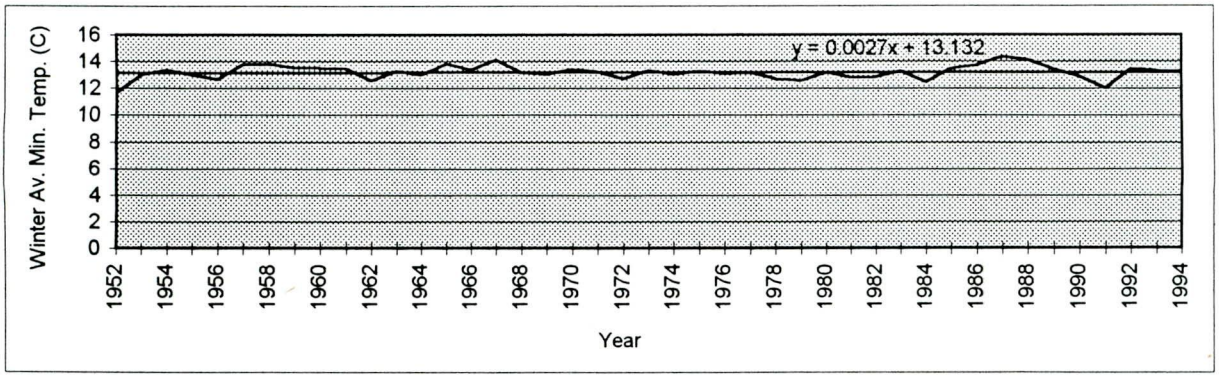


Fig. d : Trend of Winter Average Minimum Temperature in Mymensingh for 43 years (1952-1994)

Figure 3.22 : Trend of Winter Average Maximum & Minimum Temperature for Dhaka (1952-1994) & Mymensingh (1952-1994)

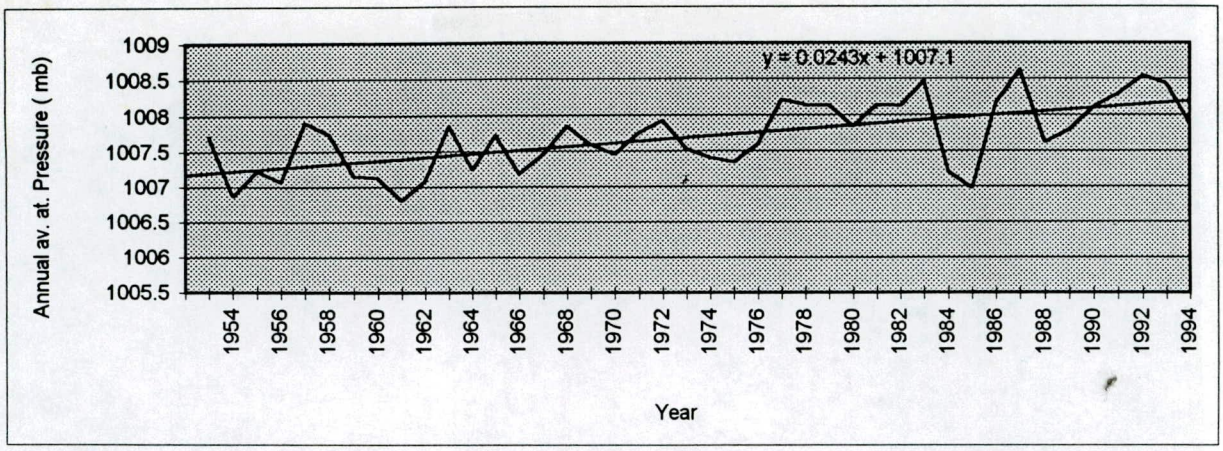


Fig. a : Annual Average Atmospheric Pressure in Dhaka for 42 years (1953-1994)

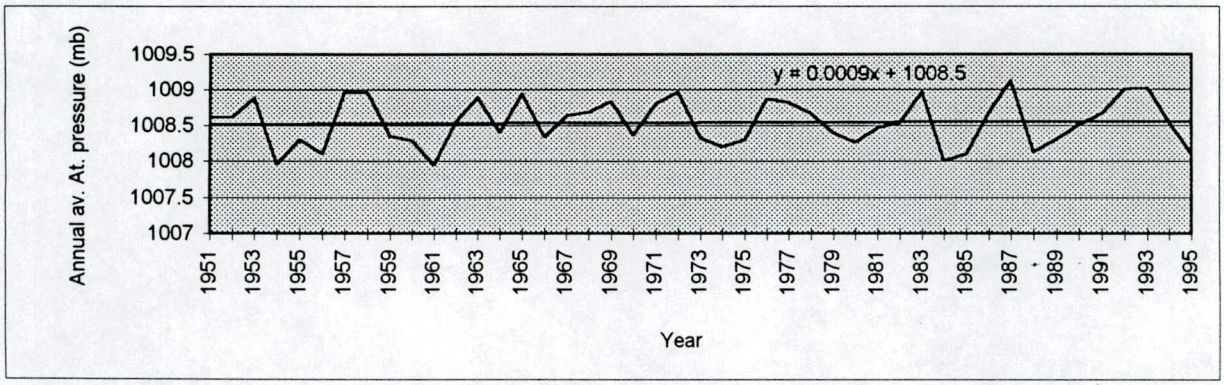


Fig. b : Annual Average Atmospheric Pressure in Mymensingh for 45 years (1951-1995)

Fig. 3.23 : Trend of Annual Average Atmospheric Pressure for Dhaka (19953-1994) & Mymensingh (1951-1995)

3.3.2.1 Significance of Trend

The data for this study were examined for presence of any trend. First, a linear regression of parameter versus time was performed. Here time is the independent and parameter is the dependent variable. The slope of regression line was tested for significance. The mean value and a linear regression equation for different data series were obtained and presented in Table 3.4. In order to test the significance of the slope of the regression equation the following hypothesis is tested.

$$H_0 : b_0 = 0.0$$

$$H_1 : b_0 \neq 0.0$$

The test statistic is calculated as follows :

$$t = \frac{(b - b_0)}{S / \sqrt{S_{xx}}}$$

where b is the computed slope, b_0 is the hypothesized slope (zero in this case), S is the standard error of estimate given by

$$S = \sqrt{\frac{S_{yy} - bS_{xy}}{n - 2}}$$

in which

$$S_{yy} = \sum_{i=1}^{n} (y_i - \bar{y})^2$$

$$S_{xy} = \sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})$$

and $$S_{xx} = \sum_{i=1}^{n} (x_i - \bar{x})^2$$

Null hypothesis H_0 is rejected if $|t| > t_{1-\alpha/2, n-2}$, α is the level of significance and n-2 is the degree of freedom.

For different data series of rainfall, temperature and atmospheric pressure, the computed mean, the regression equation, computed t statistic and the critical t-values are given in Table 3.4. From the table, it can be seen that slope is different from zero at 0.10 significance level for summer rainfall, one day annual maximum rainfall, number of monsoon rainy days, annual average maximum and minimum temperature, annual mean

temperature, one day annual maximum and minimum temperature, winter average minimum temperature and annual average atmospheric pressure of Dhaka. It is also seen that slope is different from zero at 0.10 significance level for annual rainfall, summer rainfall, monsoon rainfall, annual average rainfall, number of annual rainy days and summer average maximum temperature and one day annual maximum temperature of Mymensingh and, for all data series of rainfall of Tangail except the number of summer rainy days.

Table 3.4 : Significance test for changes in rainfall, temperature and atmospheric pressure values at 0.10 significance level

Data Series	Mean	Number of obs.	Linear Trend - Regression eq.	Significance slope Comp. t	Critical $t_{1-\alpha/2,\ n-2}$	Remarks (change)
A. Dhaka						
a. Rainfall :						
Annual rainfall	2055	43	y = 5.164x +1941.9	1.09	1.68	no
Summer rainfall	470.2	43	y = 5.9334x + 339.67	2.72	1.68	(+)
Monsoon rainfall	1348.77	43	y = -2.5101x + 1403	0.71	1.68	no
One day annual max. rainfall	136.63	43	y = -1.1012x +160.83	1.72	1.68	(-)
Annual average rainfall	67.27	43	y = 0.1699x + 63.529	1.10	1.68	no
No. of annual rainy days	120.97	43	y = 0.0094x + 120.77	0.06	1.68	no
No. of Summer rainy days	25.88	43	y = 0.1429x + 22.741	1.57	1.68	no
No. of monsoon rainy days	79.19	43	y = -0.1654x + 82.824	1.81	1.68	(-)
b. Temperature	**:**					
Annual av. max. temp.	30.4	43	y = 0.0172x + 30.041	3.07	1.68	(+)
Annual av. min. temp.	21.3	43	y = 0.0267x + 20.723	7.18	1.68	(+)
Annual mean temp.	25.9	43	y = 0.022x + 25.382	5.73	1.68	(+)
One day annual min. temp.	8.12	43	y = 0.057x + 7.1487	3.62	1.68	(+)
One day annual max. temp.	37.35	43	y = 0.0267x + 36.988	2.19	1.68	(+)
Summer av. max. temp.	33.2	43	y = 0.0016x + 33.138	0.16	1.68	no
Summer av. min. temp.	22.8	43	y = 0.0119x + 22.509	1.60	1.68	no
Winter av. max. temp.	26.6	41	y = 0.0043x + 26.485	0.45	1.68	no
Winter av. min. temp.	13.7	41	y = 0.0582x + 12.434	6.42	1.68	(+)
C. Atmospheric	**Pressure :**					
Annual av. At. Pressure	1007.7	42	y = 0.0243x + 1007.2	5.0	1.68	(+)

(+) : indicates increasing trend
(-) : indicates decreasing trend
no : indicates no change

Data Series	Mean	Number of obs.	Linear Trend - Regression eq.	Significance slope Comp. t	Critical $t_{1-\alpha/2,\ n-2}$	Remarks (change)
B. Mymensingh						
a. Rainfall :						
Annual rainfall	2344.6	45	y = 13.882x + 2025.3	2.69	1.68	(+)
Summer rainfall	453.11	45	y = 5.8599x + 318.33	2.66	1.68	(+)
Monsoon rainfall	1632.4	45	y = 6.6184x + 1480.2	1.77	1.68	(+)
One day annual max. rainfall	151.4	45	y = 0.6083x + 137.81	1.15	1.68	no
Annual average rainfall	76.68	45	y = 0.4534x + 66.255	2.74	1.68	(+)
Number of annual rainy days	114	45	y = 0.6963x+ 97.985	4.53	1.68	(+)
Number of Summer rainy days	24.67	45	y = 0.1701x + 20.755	2.10	1.68	(+)
Number of monsoon rainy days	76.56	45	y = 0.4377x + 66.489	4.67	1.68	(+)
b. Temperature :						
Annual average max. temp.	30	45	y = -0.0049x + 30.116	1.36	1.68	no
Annual average min. temp.	20.7	45	y = 0.0004x + 20.663	0.11	1.68	no
Annual mean temp.	25.3	45	y = -0.0022x + 25.389	0.75	1.68	no
One day annual min. temp.	8.32	45	y = -0.0104x + 8.5632	0.63	1.68	no
One day annual max. temp.	37.23	45	y = -0.0144x + 37.559	1.94	1.68	(-)
Summer average max. temp.	32.1	45	y = -0.0336x + 32.903	4.24	1.68	(-)
Summer average min. temp.	21.4	45	y = 0.0035x + 21.309	0.48	1.68	no
Winter average max. temp.	26.2	43	y = -0.0092x + 26.357	1.12	1.68	no
Winter average min. temp.	13.2	43	y = 0.0027x + 13.132	0.42	1.68	no
c. Atmospheric Pressure :						
Annual average At. Pressure	1008.5	45	y = 0.0009x + 1008.5	0.19	1.68	no
C. Tangail						
a. Rainfall :						
Annual rainfall	1777	34	y = 35.89x + 1148.6	5.13	1.70	(+)
Summer rainfall	353.4	34	y = 6.263x + 243.93	2.54	1.70	(+)
Monsoon rainfall	1214.7	35	y = 25.392x + 757.68	4.51	1.70	(+)
One day annual max. rainfall	121.37	35	y = 2.1462x + 82.682	2.70	1.70	(+)
Annual average rainfall	58.16	34	y = 1.1781x + 37.538	5.15	1.70	(+)
Number of annual rainy days	104.71	34	y = 0.7074x + 92.326	3.53	1.70	(+)
Number of Summer rainy days	22.24	34	y = 0.1901x + 18.909	1.34	1.70	no
Number of monsoon rainy days	71.46	35	y = 0.4401x + 63.536	2.28	1.70	(+)

3.3.3 The Moving Average Method -- by using moving average method of appropriate orders, one can estimate cyclic, seasonal and irregular patterns thus leaving only the trend movement.

For a set of numbers x_1 , x_2 , x_3 , ... x_n a moving average of order n is identified to be the sequence of arithmetic means :

$$j = 1, \quad \sum_{j=1}^{n} x_j / n \; ; \quad j \geq 2, \quad \sum_{i=j}^{n+j-1} x_i / n$$

If the data are given annually or monthly, a moving average of order n is called respectively an n-year moving average or an n-month moving average. Thus it is told of 5-year moving average, 10-year moving average etc. A 10-year moving average is the mean over successive 10-year period. The first mean is obtained for years from one to ten and plotted between 5th year and 6th year. The second mean is obtained for years from two to elevan and plotted between 6th year and 7th year, and so on.

Changes in physical conditions over a period of several years can result in corresponding changes in climatic parameter characteristics that may show up as trends in time series of given data. Evidence of real trends may be obtained by a study of progressive long term averages using 10- years moving average. Rainfall, temperature and atmospheric pressure for Dhaka and Mymensingh were investigated to identify any trend and for Tangail, only rainfall data series was examined to identify any trend.

Rainfall -- ten-year moving average data series of annual rainfall, summer rainfall, monsoon rainfall and one day annual maximum rainfall for Dhaka city are plotted in Figures 3.24 and 3.25 and data series are presented in Tables D.1 through D.4 in Appendix- D. It is seen from these figures that 10-year moving average of annual rainfall and summer rainfall for Dhaka indicates an increasing trend throughout the period; but monsoon rainfall does not show any increasing or decreasing trend and its yearly variation is much more. 10-year moving average of one day annual maximum rainfall of Dhaka exhibits a decreasing trend which started after 1970.

For Mymensingh, 10-year moving average data series of annual rainfall, summer rainfall, monsoon rainfall and one day annual maximum rainfall are plotted in Figures C.5 and C.6 in Appendix-C and data series are presented in Tables D.6 through D.9 in Appendix- D. From the above figures, it is observed that 10-year moving average of annual rainfall,

summer rainfall, monsoon rainfall and one day annual maximum rainfall for Mymensingh exhibit an increasing trend throughout the period.

Similarly in Tangail, 10-year moving average data series of annual rainfall, summer rainfall, monsoon rainfall and one day annual maximum rainfall also showed the increasing trend throughout the period. These data series of rainfall are plotted in Figures C.7 and C.8 in Appendix-C and data series are presented in Tables D.11 through D.14 in Appendix-D.

Temperature -- time series data of 10-year moving average of annual average maximum temperature, annual average minimum temperature, annual mean temperature, one day annual maximum temperature, one day annual minimum temperature, summer average maximum temperature, summer average minimum temperature, winter average maximum temperature, winter average minimum temperature for Dhaka city are plotted in Figures 3.26 through 3.28 and data series are given in Tables D.16 through D.24. It is observed from these figures that all the data series of temperature for Dhaka shows an increasing trend. Among all the data series of temperature of Dhaka, the increasing tendency of annual average maximum temperature, annual average minimum temperature, annual mean temperature, one day annual maximum temperature, one day annual minimum temperature and winter average minimum temperature are more than that of other data series of temperature. It may be concluded that increase of maximum temperature at Dhaka city has started after 1980 and the increase of minimum temperature started earlier but rate of increase of minimum temperature is more rapid after 1980.

For Mymensingh, 10-year moving average data series of annual average maximum temperature, annual average minimum temperature, annual mean temperature, one day annual maximum temperature, one day annual minimum temperature, summer average maximum temperature, summer average minimum temperature, winter average maximum temperature, winter average minimum temperature are plotted in Figures C.9 to C.11 and data series are given in Tables D.25 to D.33 in Appendix-D. It is seen from the figures that no increasing or decreasing trend is present in annual average maximum temperature, annual average minimum temperature, annual mean temperature, one day annual minimum temperature, summer average minimum temperature, winter average maximum temperature and winter average minimum temperature for Mymensingh. Only decreasing tendency of temperature is found in summer average maximum temperature and one day annual maximum temperature.

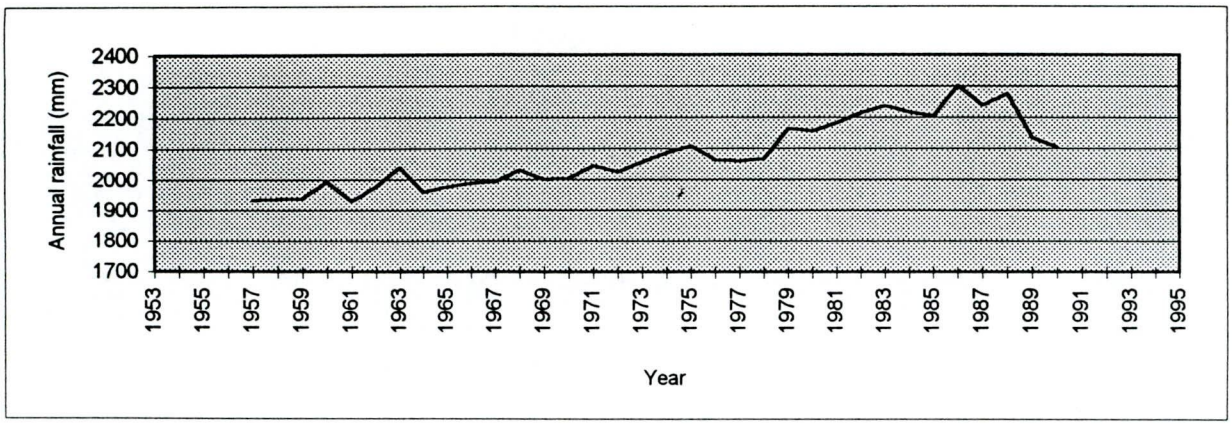


Figure a : 10-year moving average of annual rainfall in Dhaka for years (1953-1995)

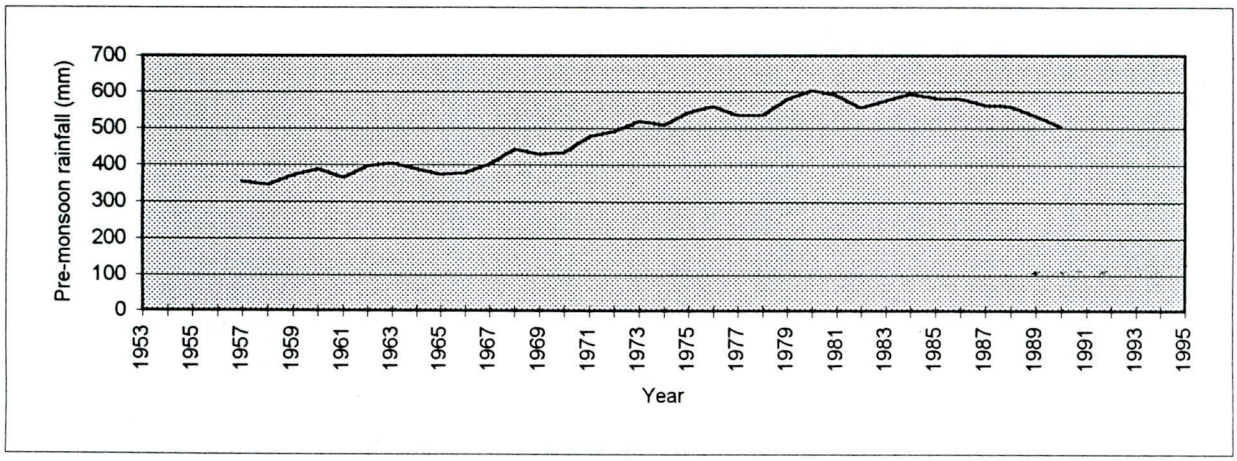


Figure b : 10-year moving average of Summer rainfall in Dhaka for years (1953-1995)

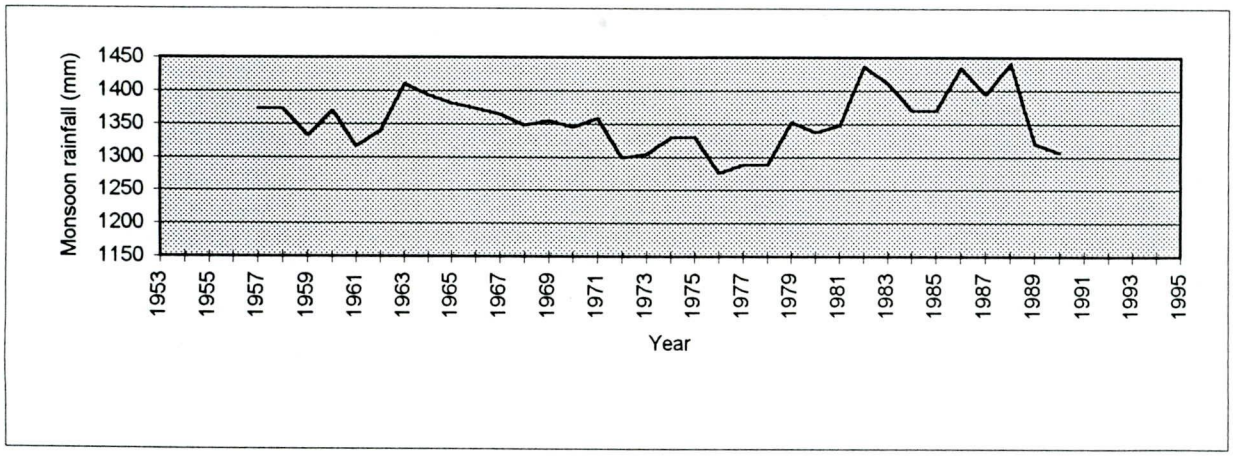


Figure c : 10-year moving average of Monsoon rainfall in Dhaka for years (1953-1995)

Figure 3.24 : Trend of 10-year moving average of Annual rainfall, Summer rainfall and Monsoon rainfall for Dhaka for 43 years period (1953-1995)

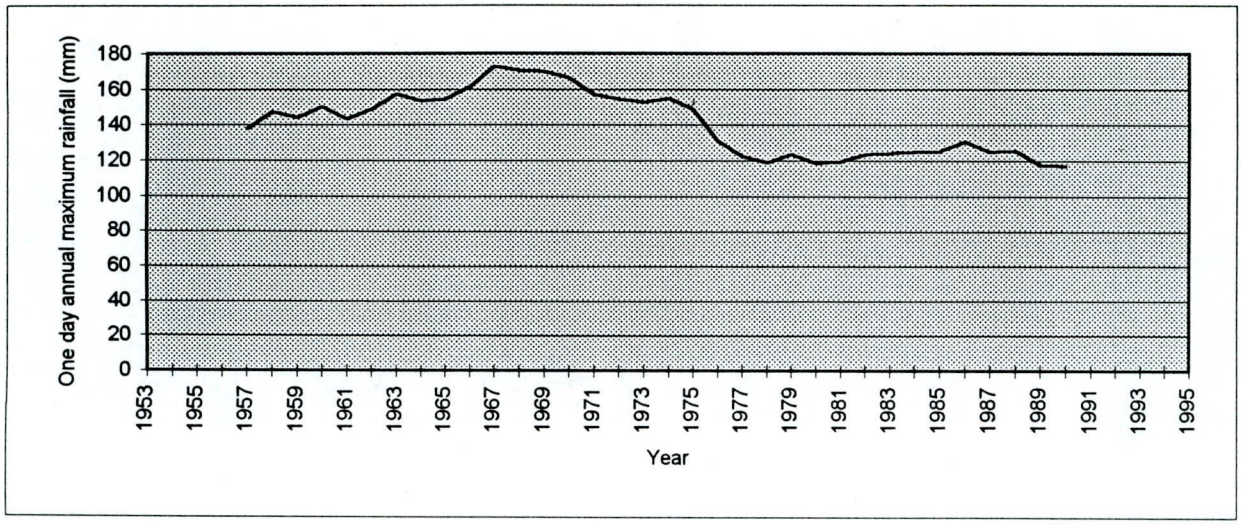


Figure 3.25 : Trend of 10-year moving average of one day annual maximum rainfall in Dhaka for 43 years (1953-1995)

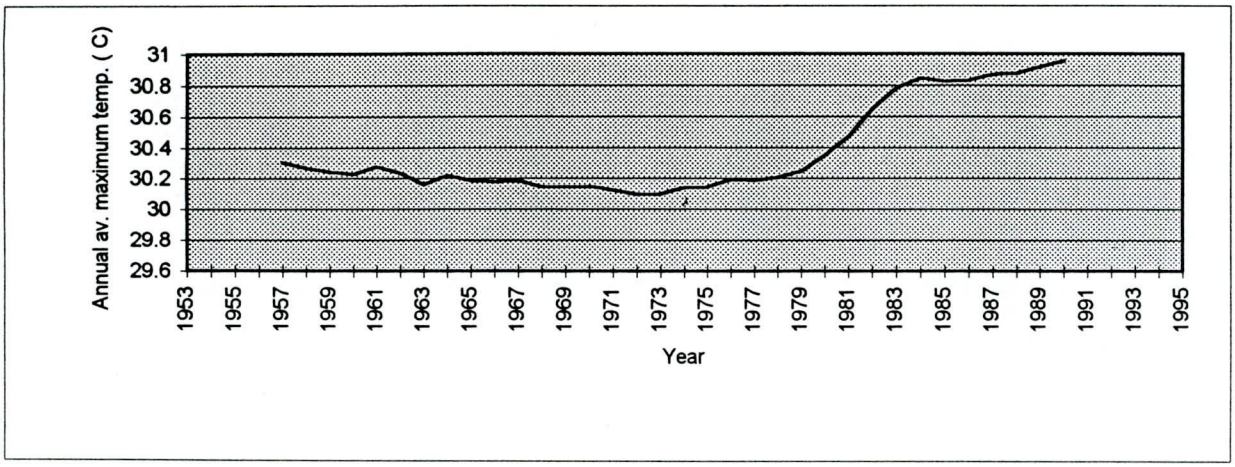


Figure a : 10-year moving average of annual average maximum temperature in Dhaka for 43 years (1953-1995)

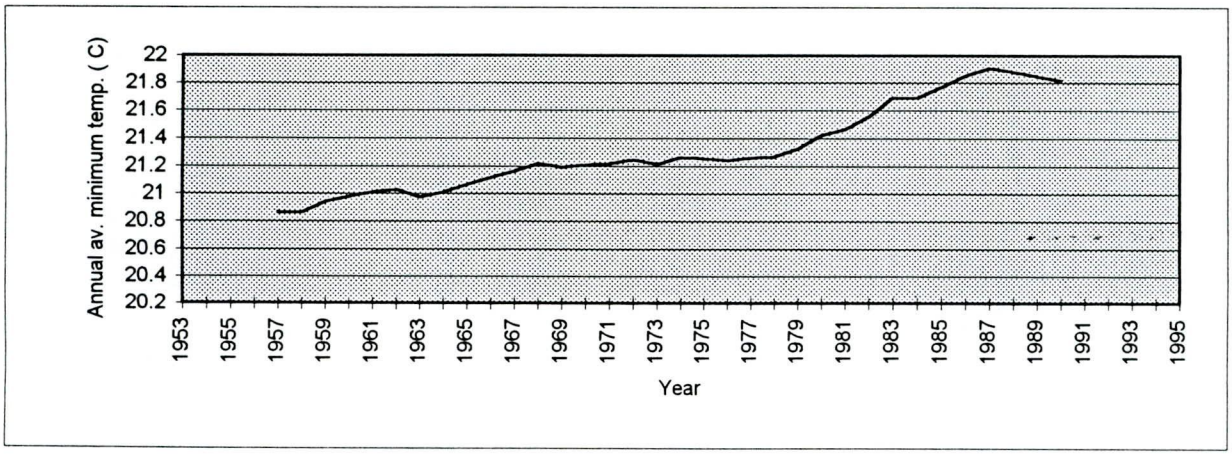


Figure b : 10-year moving average of annual average minimum temperature in Dhaka for 43 years (1953-1995)

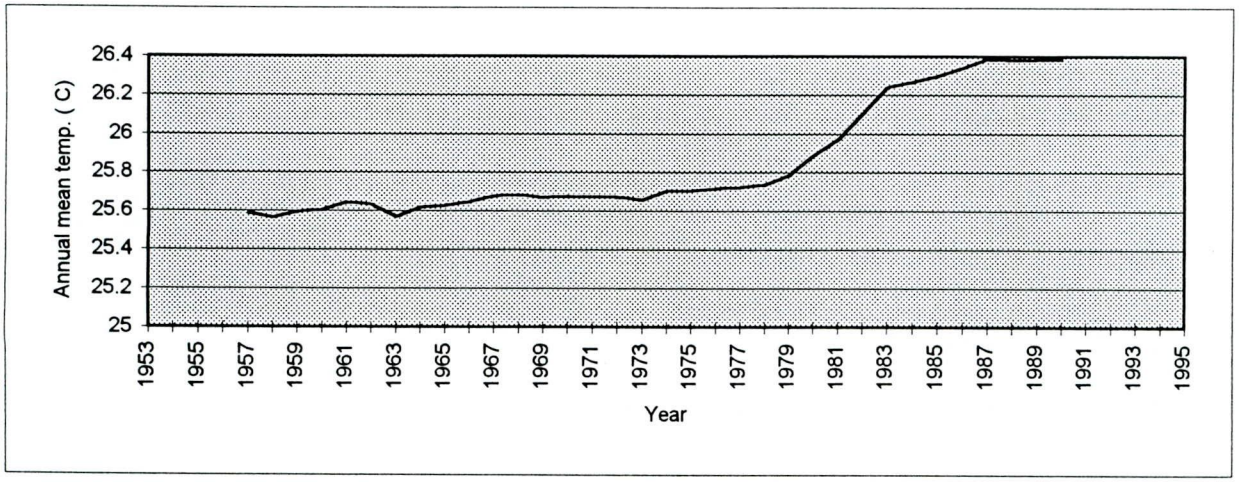


Figure c : 10-year moving average of annual mean temperature in Dhaka for 43 years (1953-1995)

Figure 3.26 : Trend of 10-year moving average of Annual average maximum, annual average minimum and annual mean temperature for Dhaka for 43 years period (1953-1995)

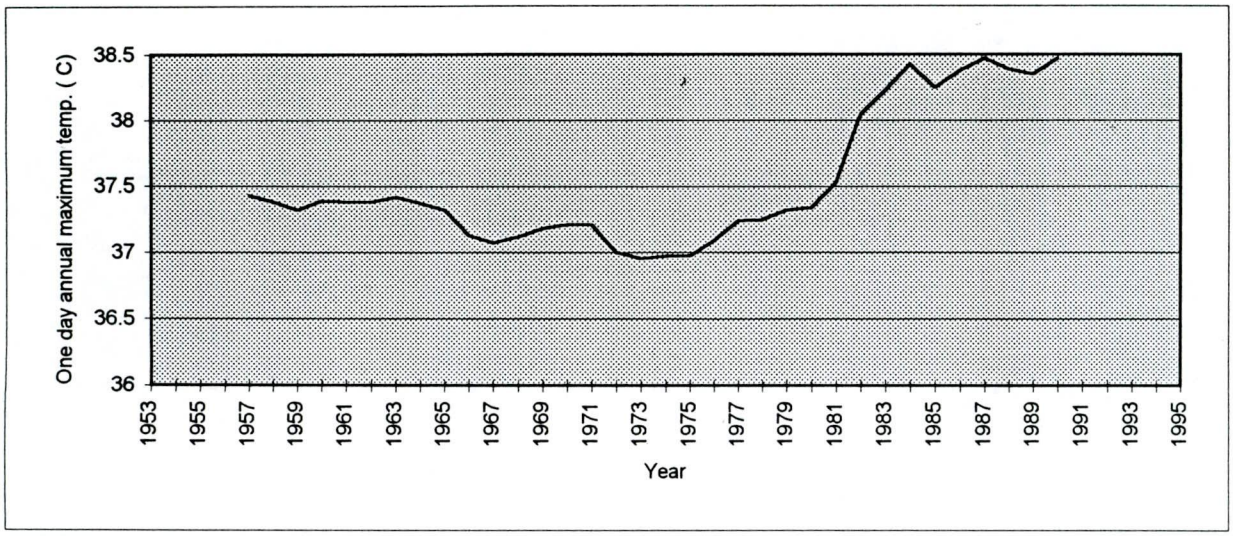


Figure a : 10-year moving average of one day annual maximum temperature in Dhaka for 43 years (1953-1995)

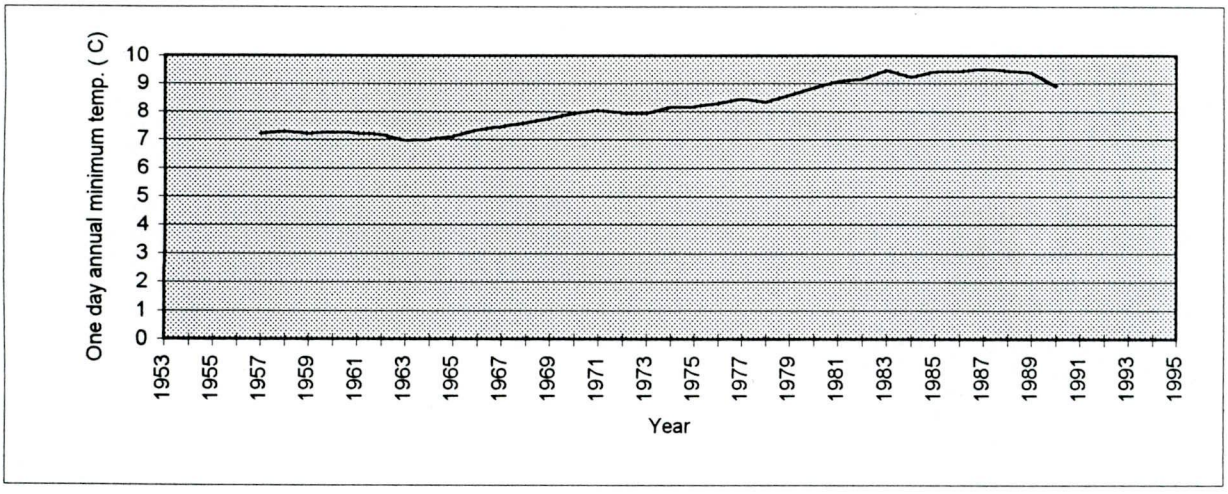


Figure b : 10-year moving average of one day annual minimum temperature in Dhaka for 43 years (1953-1995)

Figure 3.27 : Trend of 10-year moving average of One day annual maximum and One day annual minimum temperature for Dhaka for 43 years period (1953-1995)

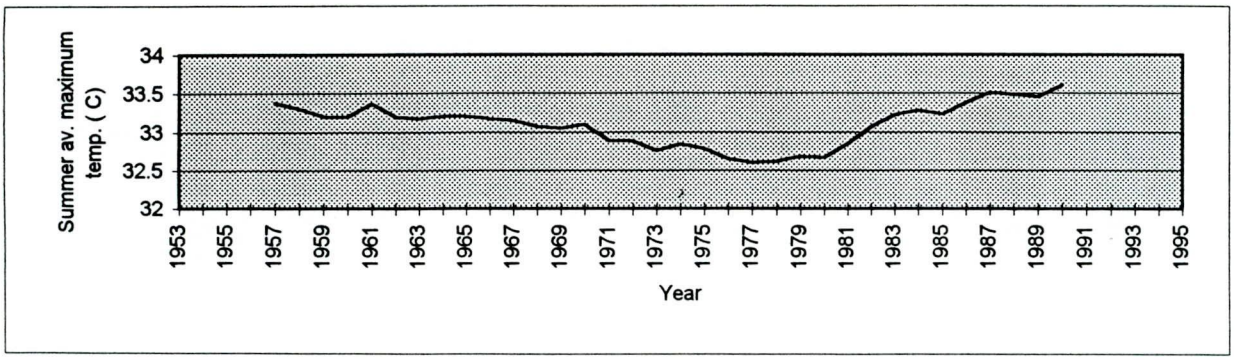


Figure (a) : 10-year moving average of summer average maximum temperature in Dhaka for 43 years (1953-1995)

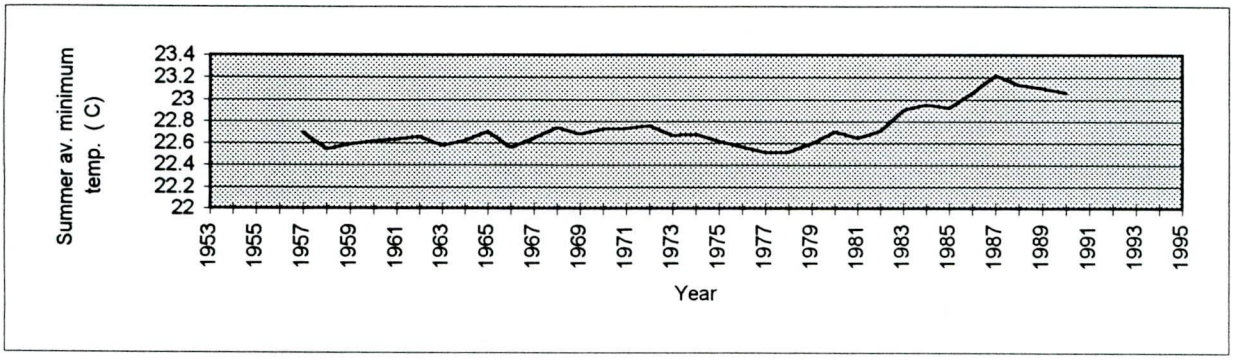


Figure (b) : 10-year moving average of summer average minimum temperature in Dhaka for 43 years (1953-1995)

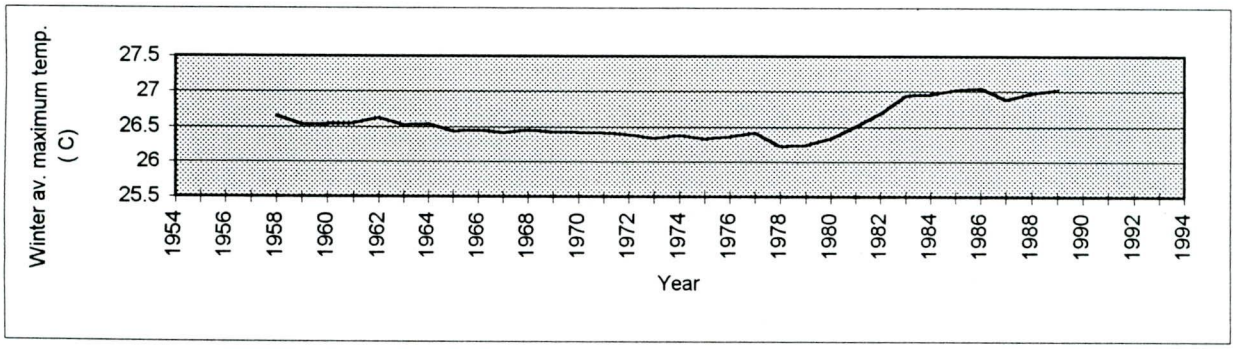


Figure (c) : 10-year moving average of Winter average maximum temperature in Dhaka for 41 years (1954-1994)

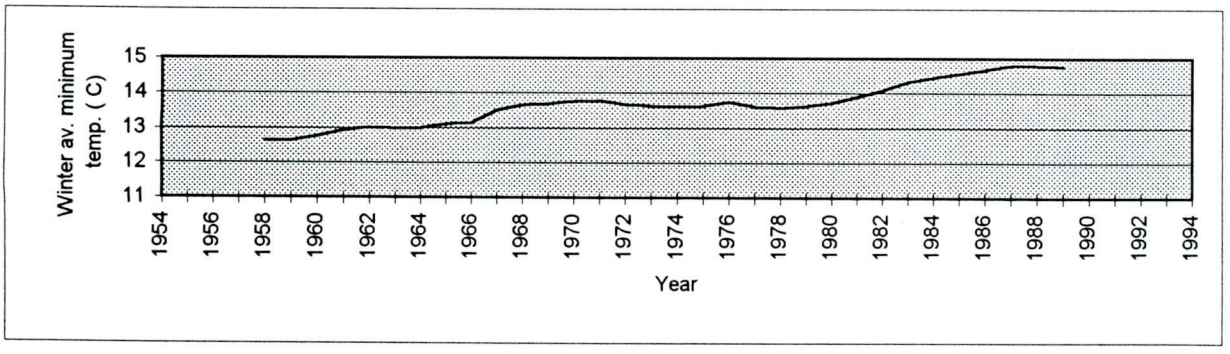


Figure (d) : 10-year moving average of Winter average minimum temperature in Dhaka for 41 years (1954-1994)

Figure 3.28 : Trend of 10-year moving average of Summer average maximum,Summer average minimum, Winter average maximum and Winter average minimum temperature minimum temperature for Dhaka for 43 years period (1953-1995)

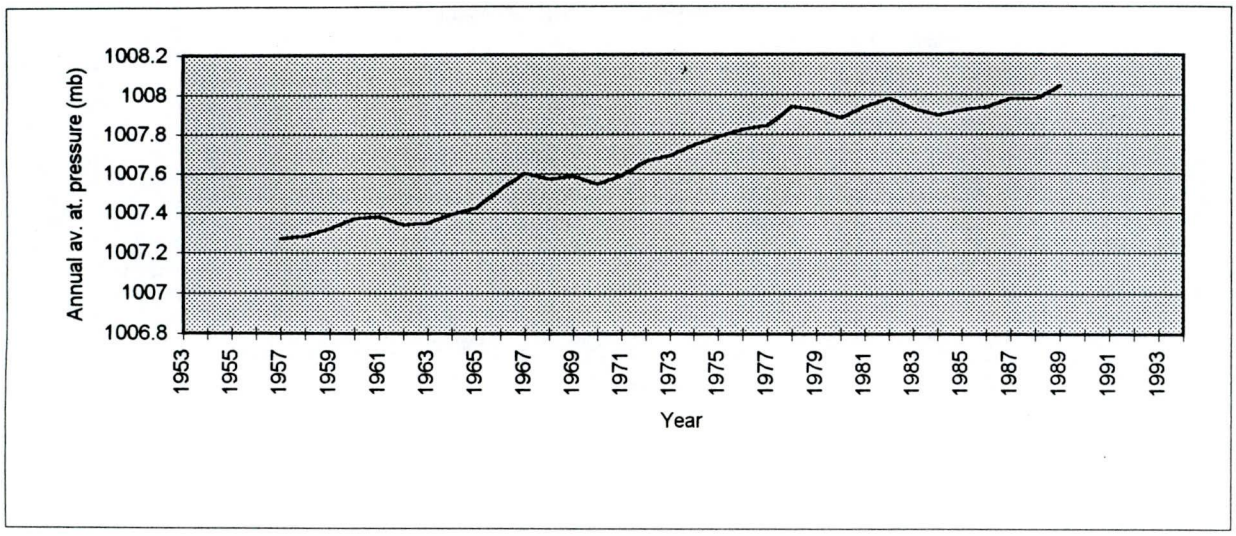


Figure (a) : 10-year moving average of annual average atmospheric pressure in Dhaka for 42 years (1953-1994)

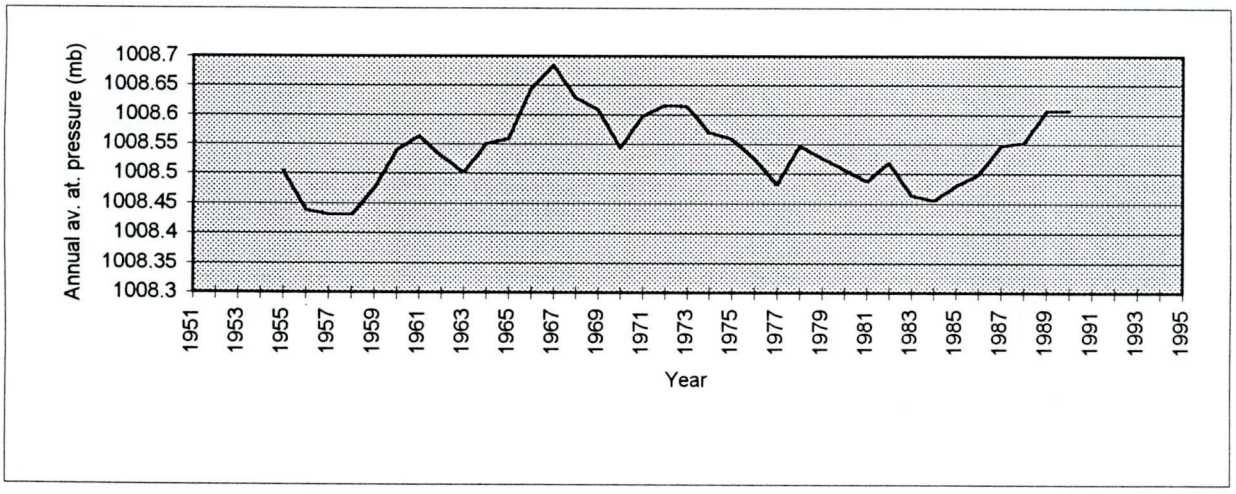


Figure (b) : 10-year moving average of annual average atmospheric pressure in in Mymensingh for 45 years (1951-1995)

Figure 3.29 : Trend of 10-year moving average of annual average atmospheric pressure in Dhaka for 42 years (1953-1994) and Mymensingh for 45 years (1951-1995)

Atmospheric Pressure -- time series data of 10-year moving average of annual average atmospheric pressure for Dhaka city and Mymensingh are plotted in Figures 3.29a and 3.29b, and data series are given in Tables D.34 and D.35 in Appendix-D. It is seen from the figures that only the data series of atmospheric pressure for Dhaka indicates the increasing trend.

3.4 Comparison of Two-period Means

Temporal variation of a given climatic parameter such as rainfall, temperature and atmospheric pressure may be detected by comparing two-period means for the chosen parameter. Two time periods 1953-1975 and 1976-1995 for Dhaka and 1951-1975 and 1976-1995 for Mymensingh were arbitrarily chosen to distinguish between temporal variation. Two-sample test were then performed to compare the means between two groups of samples. Here the test is performed to see whether or not the mean of parameters has significantly changed between the two time periods in the above stations. Usaually, t-test is employed in this type of analysis.

Student's t-Test

The t-test is the most widely used one for comparing means of two independent groups of data. The hypothesis to be tested is as follows :

$$H_0 : \mu_1 = \mu_2$$

$$H_1 : \mu_1 \neq \mu_2$$

where, μ_1 and μ_2 are the mean of a given parameter for group 1 and group 2 respectively.

The test statistic is computed as :

$$t = \frac{\bar{x}_1 - \bar{x}_2}{S_p}$$

in which x_1 and x_2 are the sample means of groups 1 and 2 respectively; t is the value of a random variable having a t-distribution with $\nu = n_1 + n_2 - 2$ degrees of freedom; n_1 and n_2 are the sample sizes for groups 1 and 2 respectively; S_p is the standard error which is given

$$S_p = \left[\frac{(n_1 - 1) S_1^2 + (n_2 - 1) S_2^2}{n_1 + n_2 - 2} \left(1/n_1 + 1/n_2 \right) \right]^{0.5}$$

in which S_1^2 and S_2^2 are the sample variances of groups 1 and 2 respectively. If $|t| < t_{\alpha/2}$, the null hypothesis H_0 is accepted which means that group 1 and group 2 do not show significant difference in means for a specified significance level α. The Two-period mean value for rainfall, temperature and atmospheric pressure, and the results are presented in Table 3.5 and 3.6, respectively. It is seen from the Table 3.5 that summer rainfall, number of summer rainy days, annual average maximum and minimum temperature, annual mean temperature, one day annual maximum and minimum temperature, winter average minimum temperature and annual atmospheric pressure has a significantly increasing change, and one day annual maximum rainfall has significantly decreasing change for Dhaka at 0.10 significance level.

Similarly for Mymensingh, annual rainfall, summer rainfall, number of annual rainy days, number of summer rainy days, number monsoon rainy days has a significantly increasing change at 0.10 significance level and also summer average maximum temperature has a significantly decreasing change at 0.10 significance level. Other events of temperature and atmospheric pressure of Mymensingh does not show any significant change.

Table 3.5 : Two-period mean value for rainfall, temperature and atmospheric pressure data series

Parameter	Mean value of two independent group			
	Station : Dhaka		Station : Mymensingh	
	Group-1 (x_1) 1953-1975	Group-2 (x_2) 1976-1995	Group-1 (x_1) 1951-1975	Group-2 (x_2) 1976-1995
a. Rainfall :				
Annual rainfall	1992 mm	2129 mm	2191 mm	2537 mm
Summer rainfall	399 mm	552 mm	365 mm	563 mm
Monsoon rainfall	1370 mm	1322 mm	1582 mm	1695 mm
One day annual max. rainfall	153 mm	118 mm	142 mm	164 mm
No. of annual rainy days	119.30	122.9	105.8	124.25
No. of summer rainy days	23.09	29.1	22	28
No. of monsoon rainy days	80.48	77.7	71.88	82.5
b. Temperature : (°c)				
Annual av. max. temp.	30.22	30.65	30.04	29.96
Annual av. min. temp.	21.04	21.62	20.69	20.65
Annual mean temp.	25.6	26.1	25.4	25.3
1- day annual min. temp.	7.46	8.87	8.43	8.19
1- day annual max. temp.	37.29	37.91	37.36	37.07
Summer av. max. temp.	33.20	33.13	32.45	31.73
Summer av. min. temp.	22.67	22.89	21.41	21.37
Winter av. max. temp.	26.52	26.64	26.17	26.13
Winter av. min. temp.	13.19	14.20	13.21	13.16
C. Atmospheric	**pressure (mb)**			
Annual av At. Pressure				
	1007.43	1008.01	1008.53	1008.54

Table 3.6 : Results of t-test showing temporal variation of rainfall, temperature and atmospheric pressure (at 0.10 significance level)

Parameter	Station : Dhaka (1953-1975 and 1976-1995)			Station : Mymensingh (1951-1975 and 1976-1995)		
	Comp. t value	Critical t value	Change	Comp. t value	Critical t value	Change
a. Rainfall :						
Annual rainfall	1.15	1.68	no	2.55	1.68	(+)
Summer rainfall	2.89	1.68	(+)	3.68	1.68	(+)
Monsoon rainfall	0.55	1.68	no	1.15	1.68	no
One day annual max. rainfall	2.22	1.68	(-)	1.60	1.68	no
Annual average rainfall	0.33	1.68	no	0.59	1.68	no
No. of annual rainy days	0.87	1.68	no	4.68	1.68	(+)
No. of Summer rainy days	2.90	1.68	(+)	5.26	1.68	(+)
No. of monsoon rainy days	1.21	1.68	no	4.19	1.68	(+)
b. Temperature :						
Annual av. max. temp.	3.13	1.68	(+)	0.83	1.68	no
Annual av. min. temp.	5.33	1.68	(+)	0.40	1.68	no
Annual mean temp.	4.89	1.68	(+)	1.25	1.68	no
One day annual min. temp.	3.8	1.68	(+)	0.57	1.68	no
One day annual max. temp.	2.11	1.68	(+)	1.55	1.68	no
Summer av. max. temp.	0.25	1.68	no	2.78	1.68	(-)
Summer av. min. temp.	1.16	1.68	no	0.21	1.68	no
Winter av. max. temp.	0.52	1.68	no	0.19	1.68	no
Winter av. min. temp.	3.83	1.68	(+)	0.32	1.68	no
C. Atmospheric Pressure :						
Annual av. At. Pressure	5.06	1.68	(+)	0.31	1.68	no

(+) : indicates increasing trend
(-) : indicates decreasing trend
no : indicates no change

3.5 Monthly and Inter-annual Variability

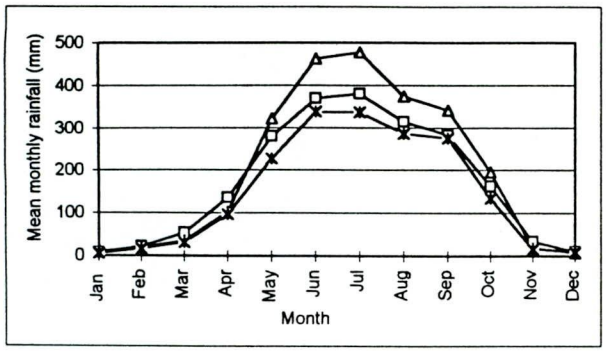
3.5.1 Variability of Mean Monthly Data

The mean monthly data series of rainfall, temperature and atmospheric pressure for Dhaka, Mymensingh and for Tangail, only mean monthly rainfall data series, and their coefficient of variation has been computed for each month and the values are given in Table D.36 to D.44 in Appendix D and these are plotted in Figure 3.30 (a and b) to 3.33 (a and b).

Rainfall -- figure 3.30 (a and b) shows the temporal variation of mean monthly rainfall for Dhaka, Mymensingh and Tangail. It is seen from the figure that the maximum rainfall occurred in July at three stations although mean monthly rainfall varies from January to December. Mean monthly rainfall during monsoon in Mymensingh is higher than Dhaka. Mean monthly rainfall during Summer is predominant in Dhaka. From the Figure 3.30 (b), it is seen that the coefficient of variation of monthly rainfall of above three stations show approximately a definite pattern of variation. Coefficient of variation of monthly rainfall has been found minimum in July when rainfall is maximum and then has an increasing trend of coefficient of variation in the subsequent month with decreasing mean monthly rainfall.

Temperature -- the temporal variation of the mean monthly maximum and minimum temperature over Dhaka and Mymensingh and their coefficient of variation have been studied and plotted in Figure 3.31 (a and b) and 3.32 (a and b) respectively. The mean monthly maximum temperature during summer season (March - May) is more higher in Dhaka than Mymensingh and maximum temperature occurred in April over two stations. From the Figure 3.31(b), it is seen that the coefficient of variation of mean monthly maximum temperature over two stations show approximately a definite pattern of variation. Although, temperature variation is approximately less in Dhaka than Mymensingh except June, November and December.

Similarly, the mean monthly minimum temperature shown in Figure 3.32 (a) is higher from February to June in Dhaka than Mymensingh and minimum temperature occurred in January over the two stations. From figure 3.32 (b), it is observed that the coefficient of variation of mean monthly minimum temperature over Dhaka and Mymensingh show approximately a definite pattern of variation except in the month of December. Although, minimum temperature variation is approximately higher in Dhaka than Mymensingh but coefficient of variation of mean monthly minimum temperature almost equal during monsoon period (June - September).



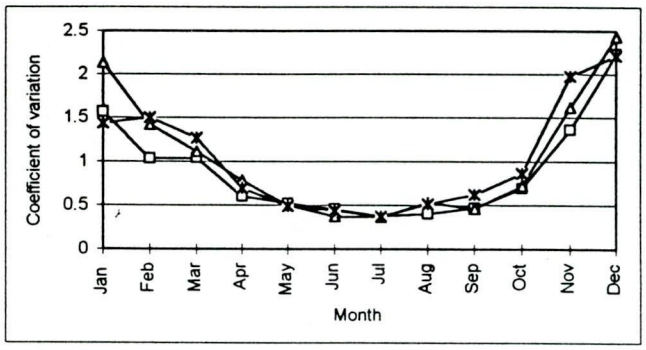
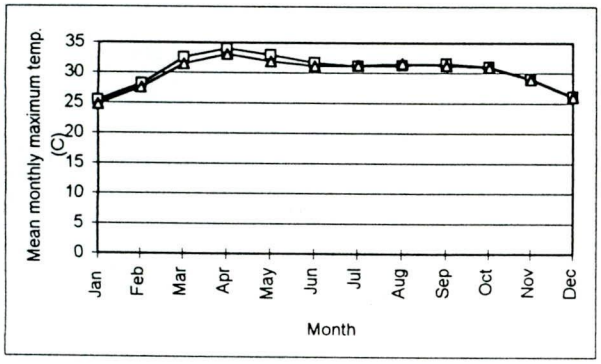


Figure 3.30 (a & b) : Temporal variation of (a) mean monthly and (b) coefficient of variation of monthly rainfall for Dhaka (1953-1995), Mymensingh (1951-1995) & Tangail (1962-1995)



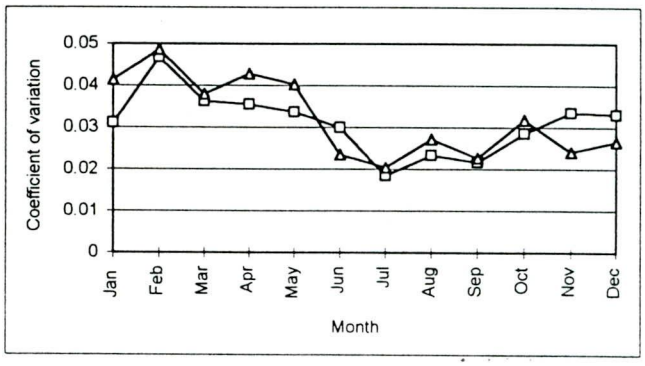
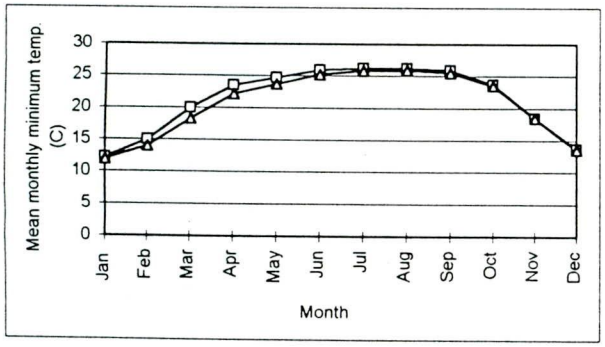


Figure 3.31 (a & b) : Temporal variation of (a) mean monthly and (b) coefficient of variation of monthly maximum temperature for Dhaka (1953-1995), Mymensingh (1951-1995)



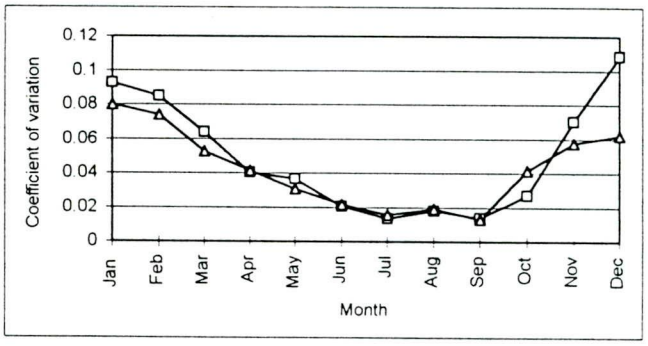
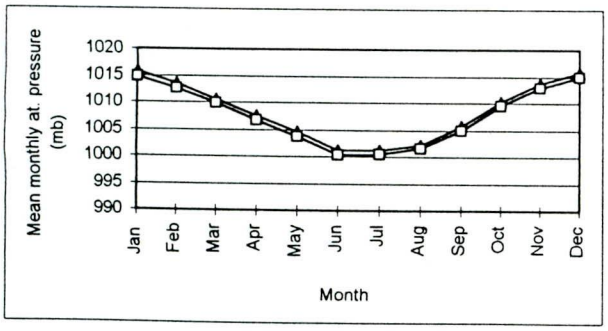


Figure 3.32 (a & b) : Temporal variation of (a) mean monthly and (b) coefficient of variation of monthly minimum temperature for Dhaka (1953-1995), Mymensingh (1951-1995)



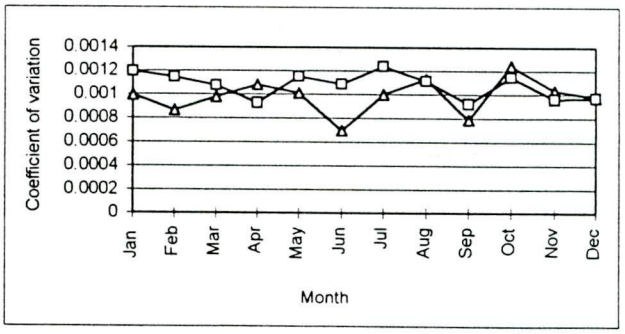
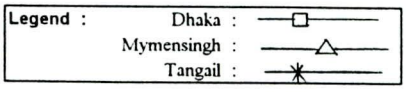


Figure 3.33 (a & b) : Temporal variation of (a) mean monthly and (b) coefficient of variation of monthly atmospheric pressure for Dhaka (1953-1994), Mymensingh (1951-1995)



Atmospheric Pressure -- figure 3.33(a and b) shows the temporal variation of mean monthly and coefficient of variation of monthly atmospheric pressure for Dhaka and Mymensingh. It is seen from the Figure 3.33(a) that the pressure in Mymensingh is all through higher than Dhaka. Atmospheric pressure is maximum in December to January and minimum in June to July over the two stations. But from Figure 3.33(b), it is observed that the coefficient of variation of mean monthly pressure of above two stations show no definite pattern of variation from January to July. Variation of pressure during this period is higher in Dhaka than Mymensingh except April.

3.5.2 Inter-annual Variability of Data Series

Generally, an interest in climatic change is stimulated by a concern about the changing probability of extreme events. Changes in the frequency and intensity of extreme events are highly sensitive to small changes in climatic variability (Katz and Brown, 1992; Katz and Acero, 1994). As a result, it is important to test for a change in the variability of selected climatic parameters- rainfall, temperature and atmospheric pressure in order to identify whether climatic parameters change has occurred. So, the coefficient of variation has been calculated in annual rainfall, annual average maximum temperature, annual average minimum temperature and annual average atmospheric pressure for Dhaka and Mymensingh, and only annual rainfall for Tangail. Coefficient of variation of time series data of selected parameters such as rainfall, temperature and atmospheric pressure are plotted against time. Any changes in parameters variability have been identified using linear regression.

Rainfall -- coefficient of variation of time series data of annual rainfall for Dhaka city, Mymensingh and Tangail are given in Tables D.36 through D.39 in Appendix-D and coefficient of variation of annual rainfall for above stations are plotted in Figures 3.34a to 3.34c. Linear regression lines are fitted to the data series of coefficient of variation of annual rainfall for three stations, and linear regression lines are shown in above figures. Changes in annual rainfall variability over three stations are illustrated in above figures. Figures 3.34a to 3.34c indicates the decreasing trend of coefficient of variation of annual rainfall for Dhaka city, Mymensingh and Tangail. But the decreasing slope of coefficient of variation in Dhaka is more among other stations. This decreasing trend of variability provides the evidence that the increase in rainfall variability is occurring at a slower rate.

Temperature -- for Dhaka city and Mymensingh, coefficient of variation of time series data of annual average maximum temperature and annual average minimum temperature are plotted against time in Figures 3.35a to 3.35d and corresponding data series are presented in Tables D.39 through D.42 in Appendix-D. Linear regression lines are fitted to

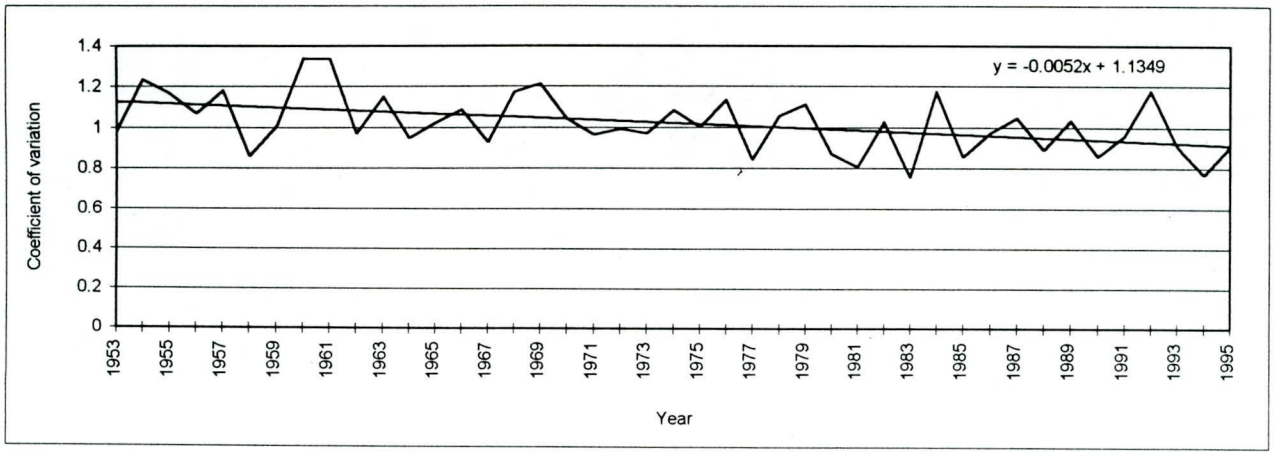


Figure 3.34a : Trend of coefficient of variation of annual rainfall over Dhaka for the period 1953-1995

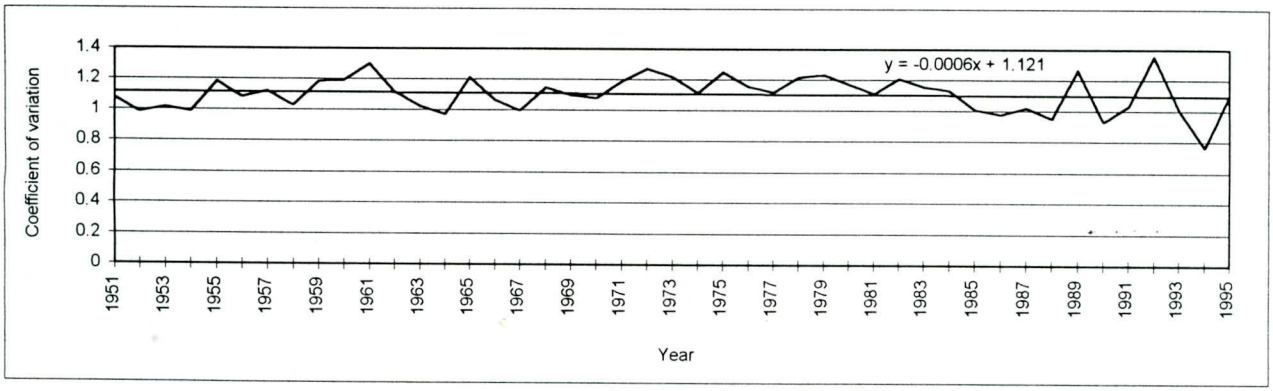


Figure 3.34b : Trend of coefficient of variation of annual rainfall over Mymensingh for the period 1951-1995

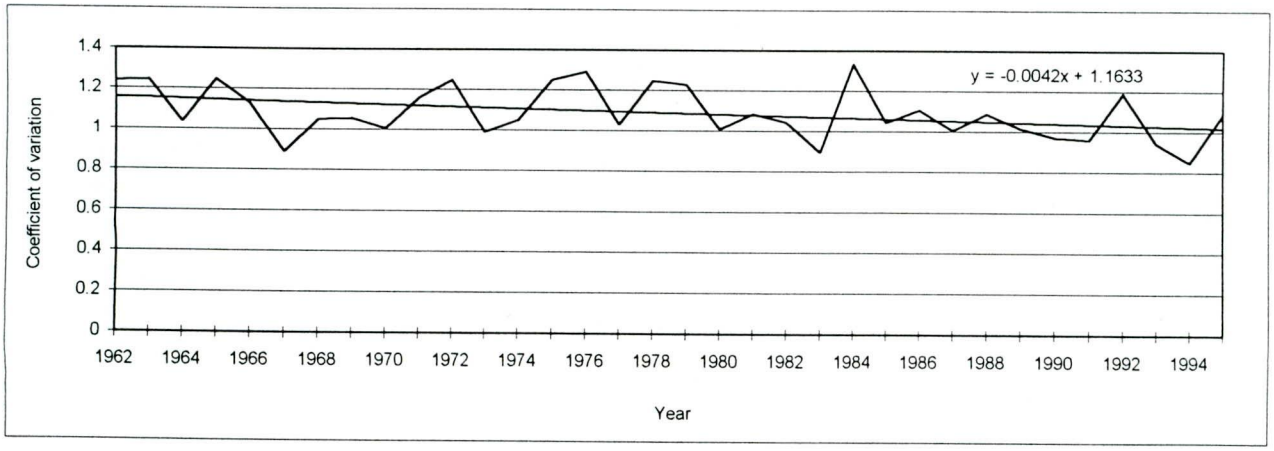


Figure 3.34c : Trend of coefficient of variation of annual rainfall over Tangail for the period 1962-1995

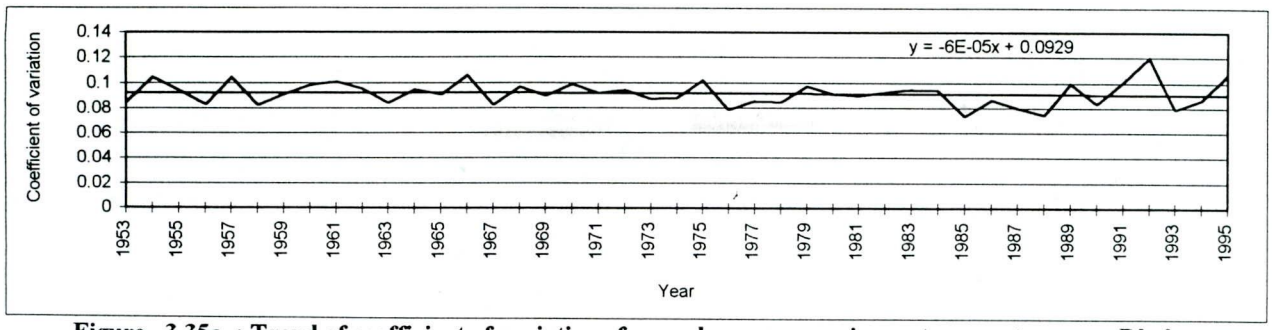


Figure 3.35a : Trend of coefficient of variation of annual average maximum temperature over Dhaka for the period 1953-1995

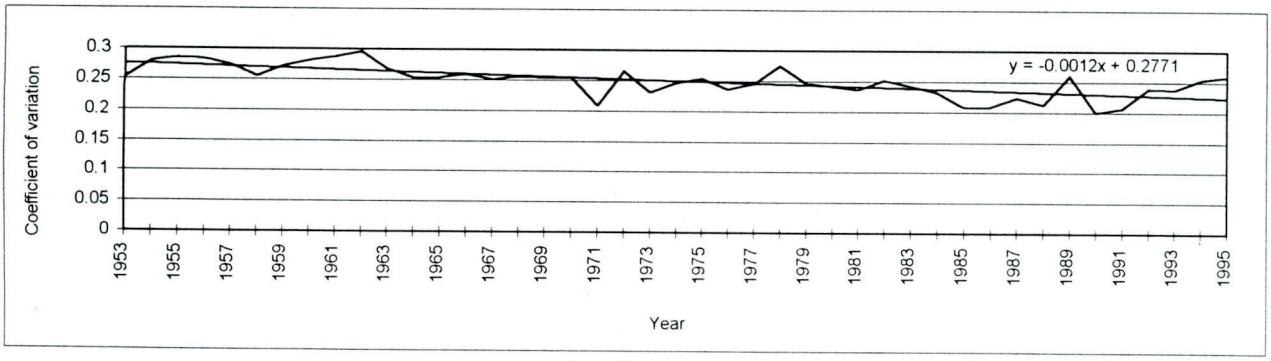


Figure 3.35b : Trend of coefficient of variation of annual average minimum temperature over Dhaka for the period 1953-1995

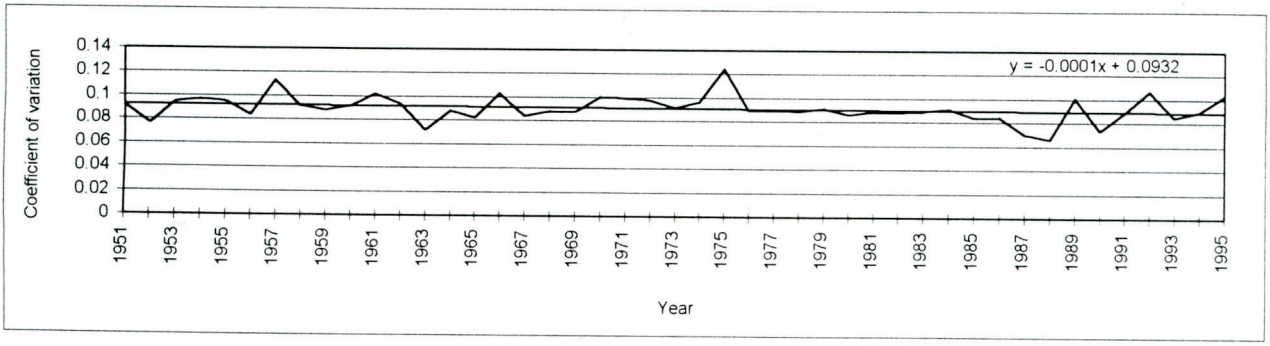


Figure 3.35c : Trend of coefficient of variation of annual average maximum temperature over Mymensingh for the period 1951-1995

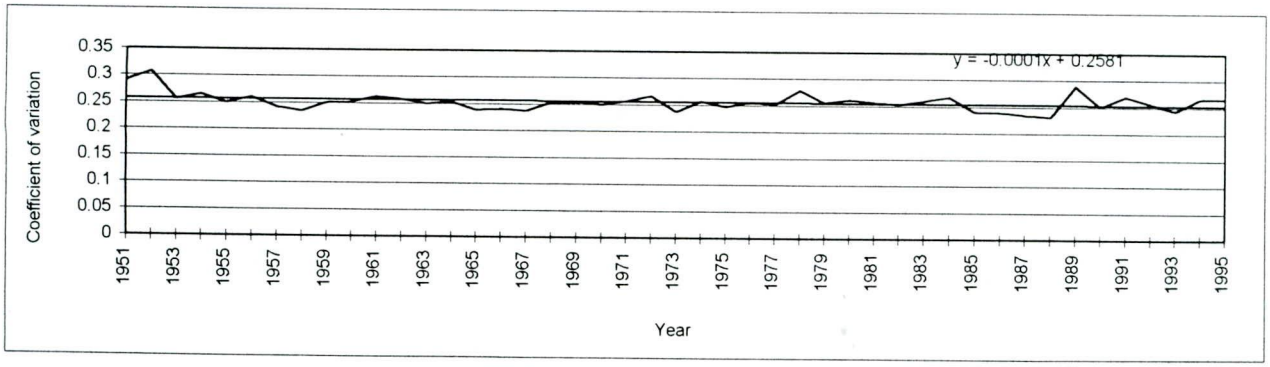


Figure 3.35d : Trend of coefficient of variation of annual average minimum temperature over Mymensingh for the period 1951-1995

the data series of coefficient of variation of annual average maximum temperature and annual average minimum temperature for Dhaka and Mymensingh, and linear regression lines are shown in above figures. Changes in annual average maximum temperature and annual average minimum temperature variability over Dhaka and Mymensingh are illustrated in Figure 3.35a to 3.35d. It is seen from the above figures that coefficient of variation of annual average maximum temperature and annual average minimum temperature over two stations have a decreasing trend. Among these data series, rate of decrease of temperature is more in annual average maximum temperature over Dhaka. This decreasing trend of variability provides the evidence that the increase in temperature variability is occurring at a slower rate.

Atmospheric pressure -- similarly, coefficient of variation of time series data of annual average atmospheric pressure for Dhaka and Mymensingh are also plotted in Figures 3.36a and 3.36b and corresponding data series are presented in Tables D.43 to D.44 in Appendix-D. Linear regression lines are fitted to the data series of coefficient of variation of annual average atmospheric pressure for Dhaka and Mymensingh, and linear regression lines are shown in above figures. These figures exhibit the decreasing trend in Mymensingh and small increasing trend in Dhaka. This decreasing trend of variability provides the evidence that the increase in pressure variability is occurring at a slower rate.

The statistical significance of the observed trends in the above coefficient of variation data series of annual rainfall, annual average maximum temperature, annual average minimum temperature and annual average atmospheric pressure are judged by t-test and results are presented in Section 3.5.2.1.

3.5.2.1 Significance of Changing Trend of Coefficient of Variation

First, linear regression analysis was performed to relate coefficient of variation of rainfall, temperature and atmospheric pressure with time. Here, time is the independent and coefficient of variation of parameters is the depended variable. The slope of the regression line was tested for significance at 0.10 significance level. A linear regression equation for each parameter were obtained and presented in Table 3.6. For each parameter, computed t statistic and the critical t-values are also given in Table 3.6. The procedure of t-test is as same as described in section 3.3.1a.

From the Table 3.7, it can be seen that the coefficient of variation of annual rainfall of Dhaka has a significant decreasing trend although there is no significant change in annual rainfall; coefficient of variation of annual rainfall for Mymensingh has no significant trend and coefficient of variation of annual rainfall for Tangail has a significantly decreasing

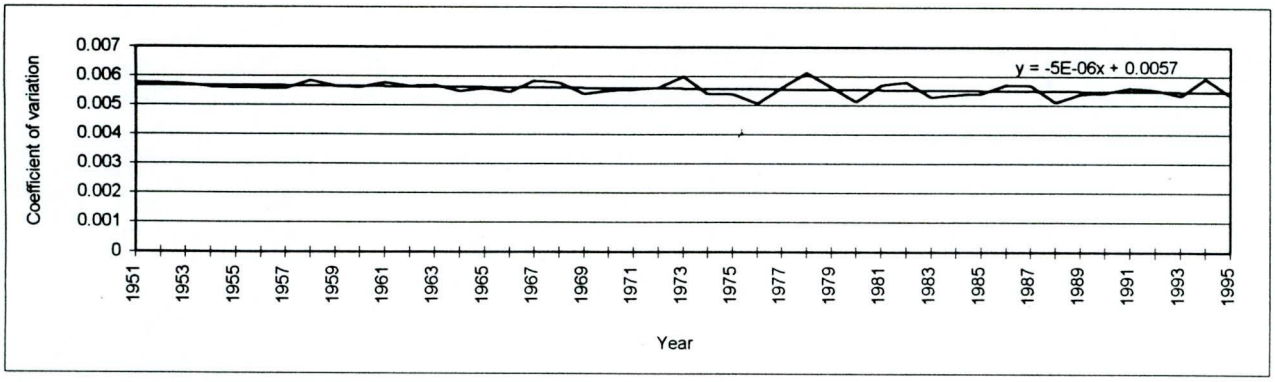


Figure 3.36a : Trend of coefficient of variation of Atmospheric Pressure over Mymensingh for the period 1951-1995

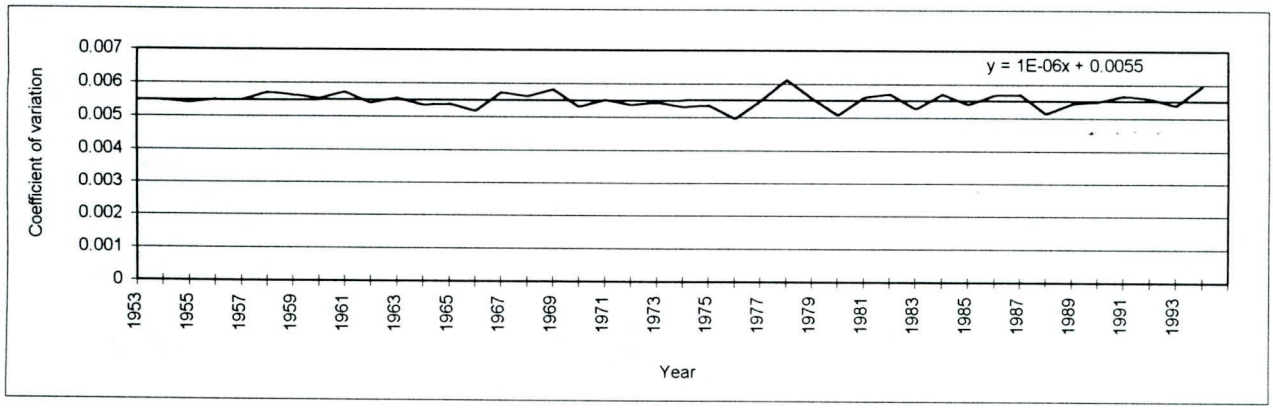


Figure 3.36b : Trend of coefficient of variation of annual average atmospheric pressure over Dhaka for the period 1953-1994

trend although it has a linear significantly increasing trend in annual rainfall. In this case, it may be concluded that the decreasing trend of variability provides that the increase in rainfall variability is occurring at a slower rate.

From the same table, it is observed that the coefficient of variation of annual average maximum temperature at Dhaka has no significant change although a significantly increasing trend is obtained in annual average maximum temperature of Dhaka. A significantly decreasing trend is observed in coefficient of variation of annual average minimum temperature of Dhaka and it has a significantly increasing trend in time series annual data. On the other hand, there is no significant trend in coefficient of variation of annual average maximum and minimum temperature in Mymensingh. But decreasing trend is observed in coefficient of variation of annual average atmospheric pressure of Mymensingh, and it has no changing trend on time series of annual data. Here, it may also be concluded that the decreasing trend of temperature or pressure variability provides that the increase in temperature or pressure variability is occurring at a slower rate.

Table 3.7 : Significance test for changes in variability of rainfall, temperature and atmospheric pressure at 0.10 significance level

Data Series	Number of obs.	Linear Trend - Significance slope			Remarks (change)
		Regression eq.	Comp. t	Critical $t_{1-\alpha/2,\ n-2}$	
CV. of Annual Rainfall of Dhaka	43	y = -0.0052x + 1.1349	3.29	1.68	(-)
CV. of Annual Rainfall of Mymensingh	45	y = -0.0006x + 1.121	0.44	1.68	no
CV. of Annual Rainfall of Tangail	34	y = -0.0042 + 1.1633	2.035	1.70	(-)
CV. of Annual Average Maximum Temperature of Dhaka	43	y = -6E -05x + 0.0929	0.50	1.68	no
CV. of Annual Average Minimum Temperature of Dhaka	43	y = -0.0012x + 0.2771	5.34	1.68	(-)
CV. of Annual Average Maximum Temperature of Mymensingh	45	y = -0.0001x +0.0932	0.79	1.68	no
CV. of Annual Average Minimum Temperature of Mymensingh	45	y = -0.0001x + 0.2581	0.56	1.68	no
CV. of Annual Average At. Pressure of Mymensingh	42	y = -5E -06x + 0.0057	1.75	1.68	(-)
CV. of Annual Average . At. Pressure of Dhaka	45	y = 1E -06x + 0.0055	0.39	1.68	no

(-) : indicates decreasing trend
no : indicates no change

Chapter 4

Results and Discussion

Results of analyses carried out in this study are summarized in Table 4.1. These can be discussed under the following headings:
(a) Rainfall (b) Surface temperature (c) Surface Atmospheric pressure.

(a) Rainfall : The time series of annual rainfall for Dhaka (1953-1995), Mymensingh (1951-1995) and Tangail (1962-1995) were examined in order to identify rainfall variability and any trend or change in pattern.

The data for rainfall were analyzed by time series plot, regression line, 10-year moving average and comparison of two period means. All the observed trends for different data series of rainfall were tested for significance at 0.10 significance level.

The trend of rainfall change in Dhaka city is found to be different from that of Mymensingh and Tangail, where extent of urbanization is lower than Dhaka. Annual rainfall and monsoon rainfall for Dhaka does not show any increasing or decreasing trend, but a significantly increasing trend is observed in summer rainfall; it depicts an increase by an amount of about 255 mm over a 43-year period. One day annual maximum rainfall for Dhaka exhibits a significantly decreasing trend, it decreases by about 47 mm over a 43-year period. On the other hand, increasing trends in annual rainfall, monsoon rainfall, summer rainfall and one day annual maximum rainfall are observed in case of Mymensingh and Tangail.

The number of monsoon rainy days for Dhaka shows a decreasing trend and number of annual rainy days does not indicate any change. But the number of summer rainy days for Dhaka shows an increasing trend. Beside that, the number of summer, monsoon and annual rainy days in case of Mymensingh and Tangail exhibit a increasing trend except the number of summer rainy days for Tangail.

The variability of mean monthly rainfall for Dhaka is approximately less in each month than for Mymensingh and Tangail. The coefficient of variation of annual rainfall for Dhaka and Tangail shows a decreasing trend whereas this coefficient of variation is very low in case of Mymensingh. This decreasing trend of coefficient of variation provides the evidence that the increase in rainfall variability is occurring at a slower rate.

Table 4.1 Summary of the results of analysis of selected climatic parameters

Climatic parameter		Results of		
		Dhaka (most urban area)	**Mymensingh (less urban area)**	**Tangail (less urban area)**
Rainfall	Annual	Data period = 1953-1995. Mean annual rainfall = 2055 mm. Standard deviation = 390 mm. Cv. of Mean annual rainfall = 18.98%. Trend of annual rainfall is not significant. Trend of one day annual maximum rainfall is significantly decreasing. Number of annual rainy days has no trend. Trend of CV. of annual rainfall is significantly decreasing.	Data period = 1951-1995. = 2345 mm. = 479.99mm. = 20.47%. Trend of annual rainfall is significantly increasing. Trend of one day annual maximum rainfall is significantly increasing Trend of number of annual rainy days is significantly increasing Trend of CV. of annual rainfall is not significantly decreasing.	Data period = 1962-1995. = 1777 mm. = 536.23 mm. = 30.18%. Trend of annual rainfall is significantly increasing. Trend of one day annual maximum rainfall is increasing. Trend of number of annual rainy days is significantly increasing. Trend of CV. of annual rainfall is significantly decreasing.
	Summer (March-May)	Data period = 1953-1995. Mean Summer rainfall = 470 mm. Standard deviation = 191.37 mm. Rainfall variability = 40.72%. Trend of Summer rainfall is significantly increasing. Trend of number of Summer rainy days is not significant.	Data period = 1951-1995. = 453.1 mm. = 206.7 mm. = 45.87%. Trend of Summer rainfall is significantly increasing. Trend of number of Summer rainy days is significantly increasing.	Data period = 1962-1995. = 353 mm. = 154 mm. = 43.63%. Trend of Summer rainfall is significantly increasing. Trend of number of premonsoon rainy days is not significa-ntly increasing.
Rainfall	Monsoon (June-September)	Data period = 1953-1995. Mean Monsoon rainfall = 1348 mm. Standard deviation = 287.45 mm. Rainfall variability = 21.32%. Trend of monsoon rainfall is not significant. Trend of number of monsoon rainy days is significantly decreasing.	= 1951-1995. = 1632.4 mm. = 3366.50 mm. = 20.61%. Trend of monsoon rainfall is significantly increasing. Trend of number of monsoon rainy days is significantly increasing.	Data period = 1962-1995. = 1215 mm. = 410.14 mm. = 33.76%. Trend of monsoon rainfall is significantly increasing. Trend of number of monsoon rainy days is significantly increasing.

		(Dhaka)	(Mymensingh)
Tempera-ture	Annual average maximum	Data period = 1953-1995 Mean of annual average max. temperature = 30.4° C. Standard deviation = 0.5045°C. Temperature variability = 1.66%. Trend of annual average maximum temp. is significantly increasing. Trend of one day annual maximum temp. is significantly increasing. Trend of CV. of annual average maximum temp. is not significant. . significant warming tendency in maximum temperature i.e. temperature is increasing.	Data period = 1951-1995 = 30.0° C. = 0.30°C. = 1.0% Trend of annual average maximum temp. is not significant. Trend of one day annual maximum temp. is not significant. Trend of CV. of annual average maximum temp. is not significant. . No remarkable change of temperature.
Tempera-ture	Annual average minimum	Data period = 1953-1995 Mean of annual average min. temperature = 21.3° C. Standard deviation = 0.50°C. Mean temperature variability = 2.35%. Trend of annual average minimum temp. is significantly increasing. Trend of one day annual minimum temp. is significantly increasing.	Data period = 1951-1995 = 20.7° C. = 0.3 °C. = 1.45%. Trend of annual average minimum temp. is not significant Trend of one day annual minimum temp. is not significant.
Tempera-ture	Annual average minimum	Trend of CV. of annual average minimum temp. is significantly decreasing. . significant warming tendency in minimum temperature i.e. night time temperature is increasing.	Trend of CV. of annual average maximum temp. is not significant. . No remarkable change of minimum temperature.
	Annual mean	Data period = 1953-1995 Mean of annual mean Temperature = 25.9° C. Standard deviation = 0.4°C. Temperature variability = 1.54%. Trend of annual mean temp. is significantly increasing. . Strong warming tendency in mean temp. i.e. temperature is increasing.	Data period = 1951-1995 = 25.3° C. = 0.257°C. = 1.02% Trend of annual mean temp. is not significant . No remarkable change of mean temperature.
	Summer average maximum (March-May)	Data period = 1953-1995 Mean of summer average max. temperature = 33.2° C. Standard deviation = 0.8104°C. Temperature variability = 2.445%. Trend is not significant.	Data period = 1951-1995 = 32.1° C. = 0.9515°C. = 2.96% Trend is significantly decreasing.

Tempera-ture	Summer average minimum (Mar-May)	Data period = 1953-1995 Mean of summer average min. temperature = 22.8° C. Standard deviation = 0.623°C. Temperature variability = 2.73%. Trend is not significant. . slight warming tendency i.e. night time temperature is slight increasing. in the occurrence of temperature.	Data period = 1951-1995 = 21.4° C. = 0.6422°C. = 3.0% Trend is not significant. . No remarkable change of temperature.
Tempera-ture	Winter average maximum (Dec-Feb)	Data period = 1954-1994 Mean of winter average max. temperature = 26.6° C. Standard deviation = 0.729°C. Temperature variability = 2.70%. Trend is not significant. . No remarkable change in winter maximum temperature.	Data period = 1952-1994 = 26.2° C. = 0.6798°C. = 2.59%. No trend. . No remarkable change in winter maximum temperature.
	Winter average minimum (Dec-Feb)	Data period = 1954-1994 Mean of winter average min. temperature = 13.7° C. Standard deviation =0.9782°C. Temperature variability = 7.14%. Trend of winter minimum temp. is significantly increasing. . strong warming tendency i.e. night time temperature is increasing.	Data period = 1952-1994 = 13.2° C. = 0.585°C. = 4.43% Trend is not significant. . No remarkable change of temperature.
Atmosph eric pressure	Annual average	Data period = 1953-1994. Mean annual average At. Pressure = 1007.7 mb. Standard deviation = 0.4785 mb. Pressure variability = 0.0475%. Trend of annual av. At. pressure is significantly increasing. Trend of CV. of annual average At. pressure is not significant. . Remarkable change of pressure.	Data period = 1951-1995. = 1008.5 mb. = 0.4 mb. = 0.0397%. No trend. Trend of CV. of annual average At. pressure is significantly decreasing. . No remarkable change of pressure.

Dhaka metropolitan area is treated as most urban area, and Mymensingh and Tangail are treated as less urban area in this study. From the above results, it is found that changes in the different data series of rainfall at Dhaka is quite different from that of Mymensingh and Tangail. Because, overabundance of cloud condensation nuclei (CCN) from soot and dust discharged by factories, houses, and various means of transportation may be preventing the formation of rain drop within urban clouds. But, if the great supply of moisture is available with the strong cyclonic winds (during summer season), the rainfall of the urban area would increase due to turbulence resulting from an increased surface roughness. It is seen that a certain change in seasonal rainfall especially in summer months has occurred at Dhaka.

(b) Surface Temperature : Linear trends of the time series of annual average maximum and minimum temperature, mean temperature and seasonal temperature were computed for Dhaka and Mymensingh for the period 1953-1995 and 1951-1995 respectively.

The data for temperature were analyzed by time series plot, regression line, 10-year moving average and comparison of two period means. Observed trends for different data series of temperature were tested for significance at 0.10 significance level.

These time series of temperature for the above stations exhibit year to year temperature variation. Annual average maximum, minimum and mean temperature for Dhaka shows an increasing trend, the amount of increase being 0.74 ^{o}C, 1.15 ^{o}C and 0.95 ^{o}C, respectively over the 43-year period. Rate of increase of temperature is seen to be predominant in case of minimum temperature for Dhaka. It is readily apparent that the greatest contribution to the warming of the mean temperature is from the increase of the minimum temperature. Similarly, one day annual maximum and minimum temperature for Dhaka also demonstrates a significantly increasing trend. It increases by 0.74 ^{o}C and 2.45 ^{o}C, respectively during 1943-1995 period. Among seasonal temperatures, only summer average minimum temperature and winter average minimum temperature indicate a increasing trend. But, the rate of increase of winter average minimum temperature is higher than summer average minimum temperature; it increases by 2.5 ^{o}C over 43-year period. On the other hand, each data series of temperature for Mymensingh does not show any significant change except summer average maximum temperature and one day annual maximum temperature; both are showing a decreasing trend. The temperature change in Mymensingh with a small downward trend is indicative of an area which is less urban in nature.

Plots of 10-year moving average of all the data series of temperature for Dhaka has showed the increasing trend. Increasing trend of all the data series of maximum temperature of Dhaka has started after 1980. Moreover, increasing trend of all data series of minimum temperature for Dhaka started earlier, but rate of increase appears to be rapid after 1980. This is because, a radical change took place in the process of urbanization in and around the city of Dhaka with the creation of Bangladesh in 1971. Many more new planned and unplanned urban development projects of different sizes and categories were implemented to meet the requirements of the capital of new state. Most of the area of Dhaka city is now covered by the paved surfaces (buildings, road networks etc.), and reduced grass and marshy land, as a results solar radiation is increased. Rapid industrialization and increasing mass transportation are likely to be responsible for temperature change in Dhaka city.

The mean monthly maximum temperature from January to June is higher in Dhaka than in Mymensingh and maximum temperature occurs in April over the two stations. The coefficient of variation of mean monthly maximum temperature over the two stations show approximately a similar pattern of variation, although temperature variation is somewhat less in Dhaka than Mymensingh. The average annual maximum and minimum temperature in Dhaka city show an increasing trend, but the respective coefficient of variations exhibit a decreasing trend. Again coefficient of variation for annual maximum temperature is found to decrease at a slower rate than that of annual minimum temperature. So, it is apparent that the decreasing trend of coefficient of variation of temperature provides the evidence that the increase in temperature variability is occurring at a slower rate.

From the above results obtained, it is observed that some warming is evident in Dhaka with the rise in minimum temperature. It is also readily apparent that the greatest contribution to the warming of the mean temperature is from the minimum temperature. It is possible that urban heat island might have caused temperature increase at Dhaka over the last four decades. This plausible from a comparison of temperature records at urban site (Dhaka) with the less urban area (Mymensingh).

Concerning diurnal variations, the greatest signature of urban heating appeared in the minimum (night time) temperature as seen in Dhaka. The less urban area (Mymensingh) examined was completely lacking for temperature increase specially in night time. Apparently in Dhaka, the night time hours, having less ventilation and greatest vertical stability, are most effective in accumulating city heat.

Increase of urban temperature does not result from the action of single factor, but is due to the complex interaction of many features of urban atmospheric system. For example, contributing factors can be (a) release of anthropogenic heat; (b) high heat capacity of building and road networks; (c) the trapping of long-wave radiation beneath roof level; (d) increased counter radiation from the urban pollution dome; (e) smoke from the mass transportation and industrialization; (f) rapid deforestation; (g) less ventilation of city air, etc.

(c) Surface Atmospheric pressure : The time series of atmospheric pressure data for Dhaka (1953-1994) and Mymensingh (1951-1995) were examined in order to identify pressure variability and trend.

The data for pressure were analyzed by time series plot, regression line, 10-year moving average and comparison of two period means. All the observed trends for different data series of pressure were tested for significance at 0.10 significance level.

The time series of annual average atmospheric pressure for Dhaka and Mymensingh demonstrated year to year pressure variation. Annual average atmospheric pressure for Dhaka exhibits a increasing trend and no such trend is present in Mymensingh. Mean monthly atmospheric pressure of Dhaka is always less than Mymensingh; mean monthly maximum pressure occurred in January and December and minimum in July over the two stations. But the coefficient of variation of mean monthly pressure of above two stations does not show a definite pattern of pressure variation. Mean monthly pressure variation is higher in Dhaka than Mymensingh except for few months. The coefficient of variation of annual average atmospheric pressure of Dhaka shows a little increasing trend which is not significant, but in Mymensingh, it is significantly decreasing and this decreasing trends provides evidence that the increase in pressure variability is occurring at a slower rate.

From the above result, it is found that certain significant change in pressure trend (increasing) obtained in Dhaka but not in Mymensingh. This change in pressure is happening along with the other parameters of Dhaka due to urbanization.

Chapter 5

Conclusion And Recommendations

5.1 Conclusion

In this study an attempt has been made to analyze data of selected climatic parameters such as rainfall, temperature and atmospheric pressure for Dhaka metropolitan area for the period from 1953 to 1995. From these results it is observed that some definite change of selected climatic parameters for Dhaka metropolitan area is taking place. Dhaka metropolis is treated as most urban area and Mymensingh and Tangail are treated as less urban area. On the basis of analysis performed and results obtained, the following conclusions may be drawn :

Rainfall

Rainfall study over Dhaka indicates the following features :

(a) Summer rainfall of Dhaka has showed a significantly increasing trend;

(b) One day annual maximum rainfall of Dhaka exhibits a significantly decreasing trend;

(c) Number of monsoon rainy days of Dhaka has showed a significantly decreasing trend;

(d) No significant increasing or decreasing trend has been observed in annual rainfall and monsoon rainfall in Dhaka;

(e) Coefficient of variation of mean annual and summer rainfall is less in Dhaka than Mymensingh and Tangail;

(f) Coefficient of variation of mean monthly rainfall is less in Dhaka than other two stations;

(g) Decreasing trend of coefficient of variation of annual rainfall provides the evidence that the increase in the rainfall variability is occurring at a slower rate.

In summary, it can be said that the summer, monsoon and annual rainfall amounts for both the non-urban stations, Mymensingh and Tangail, exhibited an increasing trend. But for Dhaka, only summer rainfall showed some increasing trend, and monsoon and annual rainfall showed a slightly decreasing trend. Such changes in rainfall pattern in Dhaka are likely due to increased urbanization.

Temperature

Temperature study over Dhaka indicates the following features :

(a) Both the annual average maximum and minimum temperature of Dhaka are increasing. Over 43- year period, these increased by about 0.74°C and 1.15°C, respectively. The increasing trend of annual average minimum temperature of Dhaka indicates a warming of the city;

(b) The trend of winter minimum temperature of Dhaka is significantly increasing. It increases by about 2.5°C over 41- year period;

(c) The trend of annual mean temperature of Dhaka is significantly warming. It is readily apparent that the greatest contribution to the warming of the mean temperature of Dhaka is from the minimum temperature. Annual mean temperature of Dhaka increases by approximately 0.945°C over 43- year period.

(d) One day annual maximum and minimum temperature of Dhaka are significantly increasing. These are increases 1.15°C and 2.37°C respectively over 43- year period.

(e) Coefficient of variation of annual average minimum temperature of Dhaka has a significantly decreasing trend. It is an evidence that the increase in temperature is taking place at a slower rate..

It is seen from this study, minimum temperature of Dhaka is increasing along with the maximum temperature which indicates the increase of night time temperature i.e. Dhaka is warming. Urbanization is likely to be one of the factors which may cause such temperature change.

Atmospheric pressure

Annual atmospheric pressure study over Dhaka indicates the sign of pressure change. This change shows an increasing trend over the period from 1953 to 1994. Coefficient of variation of annual average atmospheric pressure of Dhaka shows no significantly increasing or decreasing trend. Here, it is also likely that change of atmospheric pressure over Dhaka city along with the other selected climatic parameters might have occurred due to urbanization.

5.2 Recommendations :

Further studies in the following directions should prove to be fruitful :

(a) Heat island effect and and its relation with population.

(b) Study of long-term trends and variability of other climatic parameters, such as wind speed and direction, net radiation, humidity etc.

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APPENDIX- A : SAMPLE OF DATA

Table A.1 : BMD Sample Data Sheet - Daily and Monthly Rainfall (mm)

Government of the People's Republic of Bangladesh
Bangladesh Meteorological Department
Climate Division
Agargaon, Dhaka-1207

Station name : Dhaka **Lat. 23 Deg 46 mts. N** **Long. 90 Deg 23 mts.E**

Daily & Monthly rainfall in millimeter

Year : 1969

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	0	0	0	0	0	0	0	22	0	0	0	0
2	0	0	0	0	6	0	2	31	0	5	0	0
3	0	0	0	0	0	1	4	38	0	3	0	0
4	0	0	0	0	0	20	5	1	0	0	0	0
5	0	1	0	0	11	21	0	10	3	0	0	0
6	0	0	0	0	0	6	6	3	4	0	0	0
7	0	0	0	0	0	16	19	0	0	33	0	0
8	0	0	0	0	0	30	2	0	1	0	0	0
9	0	0	0	0	0	1	62	17	0	36	0	0
10	0	0	0	0	25	0	0	33	1	2	0	0
11	0	0	0	0	0	0	28	54	14	22	0	0
12	0	0	0	0	0	11	0	3	18	2	0	0
13	0	0	0	0	0	28	0	1	2	0	1	0
14	0	0	0	0	0	13	9	34	6	0	1	0
15	0	0	0	0	0	2	4	39	0	0	0	0
16	0	0	0	0	0	0	0	34	0	0	0	0
17	0	0	0	0	21	1	9	22	6	0	0	0
18	0	0	4	49	2	3	13	18	0	0	0	0
19	0	0	7	0	0	5	4	86	6	0	0	0
20	0	0	9	7	0	7	2	8	26	0	0	0
21	0	0	18	0	5	1	1	45	0	0	0	0
22	0	0	0	4	1	0	0	6	0	0	0	0
23	0	0	1	0	8	0	6	13	0	0	0	0
24	0	0	26	5	2	29	0	0	43	0	0	0
25	0	0	0	0	0	10	0	0	47	0	0	0
26	0	0	0	0	0	0	1	0	22	0	0	0
27	0	0	0	0	4	19	1	1	0	0	0	0
28	0	0	0	0	9	0	1	5	0	0	0	0
29	0		0	0	1	3	5	16	2	0	0	0
30	0		0	21	0	22	1	0	0	0	0	0
31	0		0		0		13	0		0		0
Total	0	1	65	86	95	249	198	540	201	103	2	0

Year : 1970

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	0	0	0	1	33	0	7	9	3	3	0	0
2	0	0	0	7	0	0	1	0	19	39	0	0
3	0	0	0	4	1	22	0	0	29	116	0	0
4	0	0	0	0	0	5	0	0	18	48	0	0
5	0	0	6	0	0	4	0	3	3	26	0	0
6	0	0	0	0	0	11	2	8	0	10	0	0
7	0	0	0	0	0	25	3	3	20	25	0	0
8	0	0	0	0	0	60	6	17	0	2	0	0
9	0	0	0	0	9	10	4	2	1	7	0	0
10	0	0	0	0	0	1	14	3	3	0	0	0
11	0	0	0	0	0	5	15	1	16	0	18	0
12	0	0	0	2	0	0	110	7	0	0	6	0
13	1	0	0	0	0	0	152	19	0	0	8	0
14	0	0	0	8	0	32	12	0	34	0	0	0
15	0	0	0	0	0	1	0	1	14	0	0	0
16	0	0	0	1	50	0	0	8	2	0	0	0
17	0	0	0	19	10	29	1	0	0	0	0	0
18	0	0	0	0	60	3	2	41	0	0	0	0
19	0	0	0	0	4	9	0	1	0	0	0	0
20	0	8	0	3	0	7	0	0	11	0	0	0
21	2	0	0	0	0	0	5	30	0	0	0	0
22	12	0	0	0	0	3	28	6	2	40	0	0
23	0	0	0	0	0	9	40	10	1	41	0	0
24	0	0	0	0	0	29	15	1	2	65	0	0
25	0	0	0	0	0	11	3	2	0	0	0	0
26	0	0	0	0	18	0	49	0	0	0	0	0
27	0	0	0	0	7	0	0	1	0	0	0	0
28	1	0	0	0	0	0	8	16	0	0	0	0
29	0		6	0	0	0	6	55	21	0	0	0
30	0		11	0	0	0	8	24	1	0	0	0
31	0		0		0		5	12		5		0
Total	16	8	23	45	192	276	496	280	200	427	32	0

Table A.2 : BMD Sample Data Sheet - Daily and Monthly Maximum Temperature

Government of the People's Republic of Bangladesh
Bangladesh Meteorological Department
Climate Division
Agargaon, Dhaka-1207

Station name : Dhaka **Lat. 23 Deg 46 mts. N** **Long. 90 Deg 23 mts.E**

Daily & Monthly max.temperature in Degree celsius

Year :- 1991

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	25.6	28.5	27.8	32.7	34.2	28.4	32	32.4	30.5	33.5	29.2	26.8
2	23.3	27.6	29.6	33.5	33.6	28	33	30	31.7	34.5	29.6	26.5
3	19.6	24.5	30.2	34.2	33.8	32.6	31.5	28.1	30	37	28.5	25.5
4	21.6	22.5	30.8	33.4	33.3	33.6	32	31.4	29.5	32.6	30.2	25
5	22.1	26	31.7	33.5	31	31	28.5	32.6	30.2	32	29.5	25.5
6	23.5	25.8	30	29.6	32.5	30.2	32	31.4	31.7	31	30	25
7	24.2	27	30.2	32.6	34	31.2	33.2	32.6	29.6	30	29	26.6
8	24.5	28.6	31	34.2	34.2	31.5	31.7	31.6	30.3	33	28.5	27
9	25.5	28.5	32	31.6	33	29.7	32.6	31.8	28	31.6	29	28.5
10	22.5	28.6	33	32.5	32.7	32.5	32.8	32.2	28.2	32.5	29.5	29.3
11	24.7	28.6	31.8	32.5	31	28	32.6	31.4	31.7	32.5	30	27.5
12	24.5	30.2	33	34.6	32.4	31.8	33.1	31.7	32.2	31.5	29.1	27.8
13	24	30.3	31.6	34.5	33	31.5	33.5	31.8	28.4	25.8	29.2	27
14	24	28.2	31.7	34.6	30.9	31.5	33.4	32.2	31.2	27.5	28	26
15	23	28.8	32.4	35	32.1	30.6	33.5	30.5	27	27.2	28.5	26.7
16	23.2	26.6	33.6	36.8	30.5	32.5	31.5	30.8	31.2	29.8	27.8	26
17	23.4	27.7	35.2	37	33	31.2	31.7	30.2	32.5	31.4	27.4	26.6
18	23.5	29.2	36	36.6	29.8	27.6	31.4	32	32.8	31.8	29.2	25.2
19	23.4	29.8	36.5	37.2	29.7	31.2	29.4	32.5	33.4	32.2	28.1	25.8
20	22.7	30.3	36.8	37.8	30.2	33.5	30.8	36.2	34.5	31.6	26.8	26.5
21	23	30.2	35.5	34.7	27.6	34	29.3	33.5	32.5	31	27	25.5
22	24.2	30.8	35.5	35	31.2	34	29.5	31.4	32	30.5	27.5	25.6
23	25.6	31.6	31.6	35	33	33	32	32.4	29.8	31.6	27	25.5
24	24.4	31.7	29.8	33.6	29.4	33.4	32.8	31.8	28.5	31.5	26.8	22.7
25	24	33	31.2	34.2	33.2	30.5	33.6	33	28.5	31.8	27.5	18.2
26	25.2	33	33	35	29.6	32.5	35	32	25.5	31	27.2	17.5
27	26.5	30	33.5	35.2	27.6	33.6	33.3	32.4	30.3	31.5	27	19.5
28	28	31	34.2	30	29.2	32.6	33.2	32.3	31	31.5	27.5	20.2
29	27.4		34	27.2	33.4	32.1	31	32.7	32.4	29	27	20.4
30	28		32.3	32.7	33.5	32.6	32.6	33	33	28.5	26	20
31	27.6		33.5		32		32.6	28.8		23.6		21.2
Mean	24.3	28.9	32.6	34	31.8	31.6	32.1	31.9	30.7	31	28.3	24.8

Year :- 1992

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	20.5	24.6	30	34.7	34.2	34.5	32.5	30	31.4	32.2	32.5	26.4
2	21.2	26.4	30.1	35	30	35.5	33.5	31.8	33	33	33.5	24.2
3	20.6	25.4	29	36.5	26.6	35.5	32	30.4	32.5	34.6	32.5	26
4	23.2	24.8	29.7	37	30	35.8	32.7	32.2	34	30.6	31.7	27.8
5	23	25.5	31.4	35.6	32.4	35	32.5	30	33	31.5	31.2	27
6	21.8	26.4	31.8	34.4	34.5	35	30.5	30.9	33.5	31.7	30.8	26
7	23.2	27	31.4	35.5	35.5	35	30.5	31	32.9	33.2	30.7	26.2
8	23.2	24.2	30.4	36.1	36	33	32.8	29.8	32.3	33.5	30	26.7
9	23.2	24.3	30.7	37.4	34.8	34.6	33	32.4	33.5	33.6	30.3	26.4
10	24.5	25.6	31.2	37	34.8	32.5	29.8	31.7	32	32.8	30.1	26.5
11	24.8	22.6	32.2	39.2	36.2	34	28	31.2	29.5	33	29	26.5
12	24.8	22.8	32.2	36.5	35.4	33.5	31.6	35.2	28.1	32.2	30.6	26.2
13	22.5	23.8	31.5	37	35.9	34.5	32.3	33.7	32.8	32.7	30.7	26.2
14	21.2	27.5	34	37.5	35.2	33.8	32.8	33.2	33.5	30	30.7	25.8
15	23.8	26.6	33.1	37.8	34.4	35	31.5	32.6	33.8	31.5	30	26
16	24.6	24.6	31	35.8	35.6	34.5	27.1	32.1	34.5	30.3	28.5	26
17	23.4	25.2	32	36	35	34.8	31.5	32.4	33.5	31.6	28.4	25.5
18	23.8	25.2	31.5	35.5	34.8	33.7	29.8	32.5	32.6	31.5	27.2	25.1
19	23.4	25.2	31.3	35.3	35.2	34	30.1	32.1	34.5	32	28.8	25
20	24	26.6	32	36.5	35	34	30.4	31.6	34.2	29.2	29.2	25.6
21	25.2	26.8	31.5	36	29.4	33.2	31.6	31.8	34.4	26.5	30.6	25.8
22	24	26	31.8	36.5	32	32.8	31.5	31.2	35	30.5	29.6	25.8
23	24.6	25.7	33.5	36.5	30.5	30.4	32	30.6	34.2	31.6	30.5	26.1
24	24	24.9	36	36.5	33.5	32	33.8	32.8	31.3	31.6	22.6	27
25	25.1	26.5	35.6	38.2	32.6	33.9	33.5	32.8	32	31.4	25.8	27.8
26	25	26.5	34.8	37.2	29.6	33.5	33.5	31.5	30.7	30.9	27.4	26
27	26.4	26.9	35.5	33.5	31	28.6	31.3	30.2	29.6	30.8	28	25.8
28	26.5	24.3	35.4	32	32.9	31.2	30.4	31.5	27.5	32.2	28.2	24.5
29	27.4	28	36.2	35.4	35.4	33.2	32.2	32.9	26	32.8	28.5	26
30	27		36.6	35.5	35.4	33.5	32.6	34.2	31	33.1	25.5	25.5
31	27.1		34.5		34.5		29.8	33.4		33.6		25.5
Mean	24	25.6	32.6	36.2	33.5	33.7	31.6	32	32.3	31.8	29.5	26.1

Table A.3 : BMD Sample Data Sheet - Daily and Monthly Minimum Temperature

Government of the People's Republic of Bangladesh
Bangladesh Meteorological Department
Climate Division
Agargaon, Dhaka-1207

Station name : Dhaka **Lat. 23 Deg 46 mts. N** **Long. 90 Deg 23 mts.E**

Daily and Monthly Min.temperature in Degree Celsius

Year:- 1985

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	13.1	19.6	19.6	25.6	21	28.1	25.9	24.8	25.4	23	20.7	16.9
2	16.1	15	21.7	25.9	23.7	23.9	26	26	26.4	26.1	21	16.3
3	15.7	13.7	22.9	26.1	21.4	27.9	26.2	25.6	26.2	26.4	20.9	14.9
4	15.5	13.8	23.3	24.3	24	23.4	26.1	27	25.4	26	21.3	16.2
5	14.3	14.8	22.9	25.2	20.3	27.1	25.1	26.6	25	26.1	21.4	15.5
6	15.4	19.8	22.9	25.8	20	27.1	25.6	25.6	26.9	25.7	20.9	14
7	16.8	16.2	23.6	23.1	19.6	25.4	26.2	24.8	26.7	24.9	21.7	15.2
8	16.1	12.3	23.8	23.9	23.4	27.7	26.7	25.6	26	26.4	18.8	15.5
9	18.9	13.9	24.1	21	25.1	28.4	26.2	26.1	27.4	25.5	18.9	15.1
10	14.3	13.7	22.4	26.4	24.4	23.6	24.8	27.5	27.1	24.5	19.8	15.6
11	12.4	15.2	22.8	27.1	26.5	24.6	26.1	28.6	25	26.7	19	15
12	12.8	16	20.7	26.8	22.7	27.2	26.6	26.7	26.8	27.1	19.3	14.8
13	12.2	15	22.4	26.8	21.2	28.6	26.4	24.8	26.6	26.1	17.4	14.6
14	12.6	15.3	22.9	26.5	22.3	27.3	26.6	27.7	24.1	26.9	15.9	15.8
15	12.5	18.9	23.8	27.2	21	25.7	26	27.3	24.5	26.1	17.5	15.6
16	15.2	16.1	25.2	26.1	23.3	25.7	25.6	27.8	25.6	25.6	18.8	16.7
17	12.5	15.9	23.3	19.8	25.8	25.6	25.7	26.1	26.2	24.4	21.2	16.9
18	12.3	14.8	24.3	21.1	25.6	23.1	25.1	27.5	26.4	25.3	23.3	17.8
19	11.6	13.9	26.6	25.1	26.8	22.8	26.4	27.2	26.6	23.9	23.1	17.8
20	12.5	14	22.8	23.4	26.9	23.1	27.1	27.5	26	23.6	19.3	15
21	13.3	16.1	24.3	26.4	27.1	27.2	26.2	27.2	23.8	21	17.1	13.4
22	13.4	16.1	25.1	23.9	25	27.1	24	27.4	26.1	21.4	16.6	13.1
23	15.4	16.1	23.9	26.9	26.7	26.8	24.7	26.2	26.8	21.3	16.7	13.7
24	14.3	15.6	19.6	26.6	26.6	26.7	26.9	26.9	24.4	20.7	16.2	15.8
25	15.6	18.1	18.2	27.2	23.3	26.6	23.4	25.8	24.9	20.6	16.5	15.7
26	14	20.6	17.1	25	23.9	26.6	23.9	26.3	26.2	21.1	16.8	15.3
27	13.1	21.4	22.1	22.3	25.4	27.7	26.6	26.4	25.1	22.4	16.7	14.8
28	16	18.6	21.9	18.2	24.2	26.8	27.2	26.7	26.4	19.7	15.9	18.4
29	16.1		20.4	21.7	24.7	26.4	26.4	27.2	26.2	20	16.7	13.6
30	17.1		25.7	22.8	27.8	24.9	26.9	26.8	26.2	20.6	16.1	12.4
31	17.8		23.9		27.5		27.3	26.9		20.4		11.9
Mean	14.5	16.1	22.8	24.7	24.2	26.2	26	26.7	25.9	23.9	18.9	15.3

Year:- 1986

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	12.2	19.5	16.3	19	20.8	27.2	25	26.8	25.3	24.4	23.9	15.6
2	13.9	16.6	17.8	25.3	23.7	27.6	25.8	27.2	26.7	25	23.3	15.6
3	13.3	15	16.4	25.1	26.6	22.7	27.4	25.6	27.2	24	24	15.6
4	13.2	13.3	16.1	18.3	21.6	26.7	26	26	25.4	26.1	24	15.7
5	11.6	14.9	17.3	22.1	24.1	28.1	25.8	25.6	26	24.9	25.4	15.6
6	13.3	17.3	18.6	19.4	20.7	28.6	26.4	26.5	26.8	24.6	23.9	15.6
7	13.6	15.8	18.9	21.8	21.1	28.6	26.7	25.1	26.8	23.4	24.7	15
8	14.2	18.3	19.4	21.7	21.7	28.9	26.3	27	26	24.1	23.8	14.2
9	16.2	18	22	21.1	24	28.9	27.2	26.8	25.6	24	21.2	14.4
10	17.7	16.6	21.1	22.4	24.6	23.9	26.2	25.6	25.6	24	18.3	15.2
11	14.4	16.6	21.9	23.1	26.2	26.7	27	27.2	25	23.9	20.7	16.7
12	16.9	18.8	22.8	22.7	22.9	26.9	27.5	26.2	24.6	24.4	18.3	15.3
13	17.7	16.6	23.8	21.3	23.9	25.3	27.4	26.9	26.1	24.1	19.1	18
14	12	18.6	24.1	25.6	22.8	27.2	27	26.4	26.4	22.5	18.6	19.4
15	12.5	20.6	22	26	27.2	26	27	26.7	26.2	23.3	18.3	17.2
16	14.5	16.6	21.3	26.9	20.7	26.7	27.4	26.3	26.8	20.6	18.6	15.6
17	11.7	14.5	18.3	26.6	22.9	26.7	27	27.5	25.6	25	18.3	17.8
18	10.6	13.4	17.3	26.7	22.2	26.7	27.2	27.8	25.9	22.5	19.7	16.1
19	11.7	12.8	20.6	25.1	20.8	27.2	26.5	26.7	26.7	23.4	19.9	16.8
20	12.2	13.6	22.1	23.3	22.8	26.8	27	27	25.3	22.8	17.8	15.4
21	11.7	15.4	21.8	21.4	26.8	26.5	26.1	26.1	25.6	21.9	17.9	17.4
22	12.8	16.2	18.9	22	24.8	26	25.6	26.7	26.4	21.9	17.8	13.9
23	13.6	19	21.4	22.8	25	26.5	25	26.2	23.9	21.7	18.1	12.2
24	13.7	17.6	22.1	24.4	25	26.6	25	26.9	23.3	20.7	18.2	12.2
25	13.5	15.5	22.8	20.8	27.1	26.2	25	27.6	24.4	21.4	17.3	14.1
26	12.6	14.9	21.8	22.1	22.2	25.8	23.9	25.6	23	21.9	17.5	13.9
27	15.8	15	19.8	20.5	22	26	24.9	25.8	21.4	22.1	16.8	12.5
28	12.8	14.4	20.7	21.1	24.7	26.1	24.7	27.4	21.7	21.6	16.2	16.2
29	15		23.4	21.2	26.1	25.4	23.9	28	23.4	21.1	16.8	13.8
30	15.8		25.1	20	26.8	24.7	26	27	23.3	22.9	15.3	11.7
31	19.6		26.3		27		26.5	27.4		25.3		12.2
Mean	13.9	16.3	20.8	22.7	23.9	26.6	26.2	26.7	25.3	23.3	19.8	15.2

Table A.4 : BMD Sample Data Sheet - Daily and Monthly Atmospheric Pressure

Government of the People's Republic of Bangladesh
Bangladesh Meteorological Department
Climate Division
Agargaon, Dhaka-1207

Station name : Dhaka **Lat. 23 Deg 46 mts. N** **Long. 90 Deg 23 mts.E**

Daily and Monthly average Atmospheric Pressure in Millibar

Year : 1953

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	1016.7	1013.7	1011.1	1011.5	1004.3	1001.1	994.3	999.4	1003.6	1007.2	1007.7	1013.5
2	1015.9	1014.7	1010.8	1009.7	1004.6	1001.4	994.3	1001	1002.6	1005.6	1007.1	1013.3
3	1017.5	1016.2	1009.5	1009.6	1004.9	1002	994.3	1002.3	1001.6	1007.3	1008	1013.4
4	1017.9	1014.4	1011.8	1008.4	1004.7	1001.8	993.5	1003.1	1003	1008.8	1009.1	1014.2
5	1017.1	1014.7	1012.6	1007.4	1005.9	1000.2	996	1003.7	1004.4	1008	1009.7	1015.5
6	1016.1	1016.2	1010.2	1007.9	1006.4	998.4	1000.5	1005	1005	1008.7	1010.1	1014.2
7	1016	1017.4	1010.1	1006.4	1004.7	998.4	1003.1	1004	1002.9	1010.2	1011.3	1015.3
8	1016.3	1017.3	1008.8	1005.2	1003.7	998.7	1002.8	1001.2	1001.4	1009.8	1010.8	1015.8
9	1015.4	1017.1	1010.6	1005.6	1003.5	1000.5	1002.1	999.6	1003.1	1009.2	1011.9	1016.2
10	1015.3	1016.6	1011.2	1005.1	1003.9	1002.1	1002.5	999	1006.3	1011.6	1011.9	1015.9
11	1014.9	1015.6	1010.1	1004.6	1002.5	1003.4	1002.4	997.8	1007.6	1013.1	1013.5	1016.2
12	1014.1	1015.1	1008.7	1004.6	1001.5	1004.7	1002.8	995.5	1006.9	1012.3	1014.5	1015.4
13	1013.5	1015.2	1007.3	1003.6	1003.4	1004.4	1004.9	996.4	1004.3	1010.8	1014.5	1014.4
14	1013.9	1014.9	1008.1	1003.5	1003.3	1004.2	1005.6	997.8	1002.3	1011.2	1014.3	1014.2
15	1013.3	1014.1	1009.5	1005	1003.1	1004.8	1003.3	997.6	1004.9	1011.1	1015.4	1013.5
16	1013.9	1012.6	1007.9	1004.8	1002.2	1003.4	1003.1	996.7	1007.1	1010.8	1013.7	1013.7
17	1014.9	1011.4	1006.1	1005.6	1002.5	1000.2	1003.3	997.2	1006.5	1010.1	1013.1	1013.9
18	1018.3	1010.5	1006	1005.2	1003.5	998.7	1003.9	997.1	1005.6	1009.3	1012.1	1014.6
19	1018.7	1011.6	1006.7	1004.7	1004.2	999	1003.6	997	1005.6	1009.5	1013.2	1013.9
20	1017.4	1015.5	1008.1	1005.6	1003.4	999.5	1002.4	997.6	1005.5	1009.9	1015	1013.9
21	1015.3	1014.9	1009.4	1006.7	1005.3	1000.6	1001.8	996.4	1006	1010.3	1015.6	1013.9
22	1014.4	1012.8	1010.7	1008.4	1004.9	1003.3	1002.8	995.9	1004.3	1009.7	1015.7	1014
23	1014.4	1011	1009.5	1008.2	1004.3	1004.6	1003.7	998.8	1002.6	1009.7	1015.7	1015.1
24	1013.8	1011.3	1007.5	1008.5	1004.8	1000.7	1003.8	1003.9	1001.1	1011.6	1014.9	1015.8
25	1015.1	1012.2	1003.4	1008.7	1005.2	997.4	1003.9	1004.1	1001.9	1011.6	1013.9	1015.7
26	1013.9	1013.3	1002.2	1008.9	1004.2	995.6	1003.3	1005	1002.4	1010.8	1014.2	1014.6
27	1012.7	1010.8	1003.1	1007.6	1002.5	995.3	1001.1	1006.3	1006.4	1008.6	1013.7	1013.6
28	1012.7	1010.5	1005.9	1006.7	1000.3	995.3	1000.7	1006.9	1007.8	1008.4	1013.8	1014.3
29	1012.7		1007.8	1006.4	1000.3	994.6	1002.7	1008.1	1007	1008.7	1013.9	1014.3
30	1012.9		1009.2	1006.7	999.4	994.7	1000.7	1008.3	1007.7	1007.6	1013.2	1014.5
31	1012.3		1011		1000.5		999.1	1005.5		1008.1		1014.8
Mean	1015.1	1014	1008.6	1006.7	1003.5	1000.4	1001.4	1001	1004.6	1009.7	1012.8	1014.6

Year : 1954

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	1014.9	1015.4	1010.5	1005.4	1005.5	999.3	1000.5	1000.5	1001.8	1006.4	1011.8	1012
2	1014.5	1015.6	1007.1	1007.4	1004.5	999.6	999.9	1001.3	1002.3	1006.5	1011.8	1013
3	1015.5	1014.2	1007.4	1007	1006	998.4	999.8	1000.4	1001.9	1006	1011.3	1013.9
4	1014.8	1013	1008.1	1006.5	1004.7	997.8	998.7	999	1002.2	1006.1	1012.1	1013.2
5	1014.1	1012.7	1009.7	1005.9	1003.2	996.6	999.4	997.6	1002.6	1005.6	1011.8	1011.5
6	1014.6	1014.7	1011.1	1004.4	1003.2	996.6	1000.4	998.4	1002.4	1005.7	1011	1009.3
7	1013.6	1017.8	1010.6	1004.2	1003.6	997.7	1000	998	1004.7	1006	1010.9	1011.3
8	1011.8	1016.7	1010.6	1004.1	1002.3	997	1000.2	997.9	1004.4	1005.8	1011.9	1014.9
9	1010.1	1015.1	1010.3	1003.8	1001.1	996.1	1001.1	998.2	1003.9	1006.2	1012.2	1014.8
10	1012.2	1014.6	1010	1003.8	999.7	996.2	1001.2	998.2	1002.6	1009.3	1012.1	1014.2
11	1013.6	1010.5	1009.1	1003.8	999.8	997.6	1000.2	998.8	1002.8	1011.5	1011.5	1014.1
12	1014	1006.4	1010.3	1004.4	1000.3	997.2	998.8	1000.4	1001.7	1010.6	1011.5	1013.4
13	1013	1006.2	1010.3	1005	1001.2	997.3	997.6	997.9	1000.6	1009.8	1013.1	1015.4
14	1013.9	1007	1011.8	1003.7	1002.8	998.4	999.2	997.1	999.6	1010.7	1014.3	1016.5
15	1015.2	1008.2	1011.7	1002.3	1003.5	999.4	1001.2	997.9	1000.8	1012.1	1014.5	1016.1
16	1014.9	1010.4	1012.9	1003.4	1002.9	1000.2	1000.7	999.4	1001.4	1011.1	1014.7	1013.1
17	1014	1013.5	1012.6	1005	1002.2	1002.2	1001.7	1000.9	1001.7	1010.4	1014.7	1011.7
18	1013.2	1011.4	1011.4	1004.8	1002.6	1003.4	1002.7	1000.5	1002.9	1010.8	1015.5	1013.2
19	1011.7	1010.8	1011.1	1006.5	1003.1	1003.3	1002.9	1000.7	1003.5	1011.3	1016.4	1014.3
20	1009.8	1012.6	1010.7	1006.8	1002.8	1003.3	1001.2	999.8	1000.8	1011.7	1015.2	1014.3
21	1009.5	1011.5	1010.8	1006.8	1003.4	1002.7	1000.5	1000.9	1002.5	1012	1013.9	1015.3
22	1012.6	1008.6	1011.5	1007.3	1002	999.7	1000.7	1000.4	1005.2	1013.3	1013	1014.8
23	1013.5	1007.2	1011.2	1005.5	1002.4	997.5	1003.3	999.6	1005.1	1012.8	1013.5	1014.5
24	1011.7	1007	1011	1002.9	1002.3	998.4	1004.1	1001.7	1002.8	1010.3	1013.8	1014.4
25	1012.8	1008.8	1010.2	1002.8	1001.2	1001.2	1002.5	1003.5	1002.2	1007	1012.9	1013.2
26	1013.3	1011.3	1008.1	1004.7	1000	1002.6	1000.7	1003.8	1004.3	1002.4	1012.9	1013.2
27	1014.7	1010.5	1006.3	1006.6	1001.1	1002.5	1002	1003.2	1006.2	1007.3	1014.4	1013.7
28	1015	1010.8	1005.9	1005.9	1003.5	1001.7	1003.8	1003	1006.2	1009.2	1015.8	1012.7
29	1014.6		1005.3	1005.9	1004.2	1000.6	1004.2	1002.5	1005	1010.6	1013.3	1012.5
30	1014.5		1005.1	1006.4	1001.2	1001.1	1001.5	1002.9	1005.3	1011.8	1012.2	1013.8
31	1014.6		1004.9		999.2		999.9	1001.7		1011.8		1016.6
Mean	1013.5	1011.6	1009.7	1005.2	1002.5	999.6	1001	1000.2	1003	1009.1	1013.2	1013.8

APPENDIX- B : STATISTICAL CHARACTERISTICS

Table B.1 : Statistical characteristics and frequency table of Rainfall for Dhaka city (1953-1995)

Annual Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	2055	1150-1350	1250	2	4.651162791
Standard dev.	390.044	1350-1550	1450	2	4.651162791
Standard Error	380.12	1550-1750	1650	4	9.302325581
variance	152134.3	1750-1950	1850	10	23.25581395
Median	2053	1950-2150	2050	8	18.60465116
Skewness	0.16	2150-2350	2250	7	16.27906977
Minimum	1159	2350-2550	2450	7	16.27906977
Maximum	3028	2550-2750	2650	0	0
Count	43	2750-2950	2850	2	4.651162791
		2950-3150	3050	1	2.325581395
			Total	43	

Monsoon Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	13487.74	650-800	725	2	4.651162791
Standard dev.	287.4538	800-950	875	2	4.651162791
Standard Error	282.39	950-1100	1025	2	4.651162791
variance	82629.68	1100-1250	1175	9	20.93023256
Median	1363	1250-1400	1325	9	20.93023256
Skewness	0.15	1400-1550	1475	9	20.93023256
Minimum	703	1550-1700	1625	6	13.95348837
Maximum	2120	1700-1850	1775	2	4.651162791
Count	43	1850-2000	1925	1	2.325581395
		2000-2150	2075	1	2.325581395
			Total	43	

One day Annual Max. Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	136.627	50-75	62.5	4	9.302325581
Standard dev.	53.999	75-100	87.5	7	16.27906977
Standard Error	51.5	100-125	112.5	10	23.25581395
variance	2915.892	125-150	137.5	10	23.25581395
Median	128	150-175	162.5	6	13.95348837
Skewness	1.44	175-200	187.5	2	4.651162791
Minimum	58	200-225	212.5	0	0
Maximum	326	225-250	237.5	1	2.325581395
Count	43	250-275	262.5	2	4.651162791
		275-300	287.5	0	0
		300-325	312.5	1	2.325581395
			Total	43	

Summer Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	470.2	75-150	112.5	1	2.325581395
Standard dev.	191.369	150-225	187.5	2	4.651162791
Standard Error	175.56	225-300	262.5	4	9.302325581
variance	36622.09	300-375	337.5	5	11.62790698
Median	428	375-450	412.5	10	23.25581395
Skewness	0.33	450-525	487.5	4	9.302325581
Minimum	43	525-600	562.5	5	11.62790698
Maximum		600-675	637.5	6	13.95348837
Count		675-750	712.5	1	2.325581395
		750-825	787.5	3	6.976744186
		825-900	862.5	2	4.651162791
			Total	43	

No. of Annual Rainy Days

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	120.9767	90-96	93	3	6.976744186
Standard dev.	13.8228	96-102	99	2	4.651162791
Standard Error	13.66	102-108	105	4	9.302325581
variance	191.069	108-114	111	3	6.976744186
Median	124	114-120	117	7	16.27906977
Skewness	-0.23	120-126	123	6	13.95348837
Minimum	92	126-132	129	10	23.25581395
Maximum	152	132-138	135	3	6.976744186
Count	43	138-144	141	4	9.302325581
		144-150	147	0	0
		150-156	153	1	2.325581395
			Total	43	

No. of Monsoon Rainy Days

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	79.186	60-64	66	1	2.325581395
Standard dev.	7.7128	64-68	66	4	9.302325581
Standard Error	7.34	68-72	70	3	6.976744186
variance	59.487	72-76	74	8	18.60465116
Median	80	76-80	78	6	13.95348837
Skewness	0.17	80-84	82	11	25.58139535
Minimum	64	84-88	86	6	13.95348837
Maximum	99	88-92	90	2	4.651162791
Count	43	92-96	94	1	2.325581395
		96-100	98	1	2.325581395
			Total	43	

No. of Summer Rainy Days

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	25.8837	10-14	12	2	4.651162791
Standard dev.	7.4966	14-18	16	6	13.95348837
Standard Error	7.334	18-22	20	7	16.27906977
variance	56.199	22-26	24	9	20.93023256
Median	25	26-30	28	7	16.27906977
Skewness	0.31	30-34	32	6	13.95348837
Minimum	13	34-38	36	4	9.302325581
Maximum	43	38-42	40	1	2.325581395
Count		42-46	44	1	2.325581395
			Total	43	

Annual Average Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	67.2677	33-40	36.5	1	2.325581395
Standard dev.	12.7546	40-47	43.5	1	2.325581395
Standard Error	12.43	47-54	50.5	5	11.62790698
variance	162.679	54-61	57.5	9	20.93023256
Median	67.09	61-68	64.5	7	16.27906977
Skewness	0.15	68--75	71.5	9	20.93023256
Minimum	37.9	75-82	78.5	7	16.27906977
Maximum	99.0	82-89	85.5	1	2.325581395
Count	43	89-96	92.5	2	4.651162791
		96-103	99.5	1	2.325581395
			Total	43	

Table B.2 : Statistical characteristics and frequency table of Rainfall for Mymensingh (1951-1995)

Annual Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	2344.6	1350-1550	1450	1	2.222222222
Standard dev.	479.9857	1550-1750	1650	2	4.444444444
Standard Error	445.09	1750-1950	1850	6	13.33333333
variance	23038506	1950-2150	2050	9	20
Median	2317	2150-2350	2250	7	15.55555556
Skewness	0.35	2350-2550	2450	6	13.33333333
Minimum	1368	2550-2750	2650	4	8.888888889
Maximum	3311	2750-2950	2850	4	8.888888889
Count	45	2950-3150	3050	2	4.444444444
		3150-3350	3250	4	8.888888889
			Total	45	

Monsoon Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	1632.4	900-1050	975	3	6.666666667
Standard dev.	336.5	1050-1200	1125	0	0
Standard Error	321.45	1200-1350	1275	9	20
variance	113232.3	1350-1500	1425	5	11.11111111
Median	1671	1500-1650	1575	5	11.11111111
Skewness	-0.02	1650-1800	1725	7	15.55555556
Minimum	969	1800-1950	1875	8	17.77777778
Maximum	2375	1950-2100	2025	5	11.11111111
Count	45	2100-2250	2175	2	4.444444444
		2250-2400	2325	1	2.222222222
			Total	45	

One day Annual Max. Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	151.8	80-100	90	5	11.11111111
Standard dev.	46.5706	100-120	110	11	24.44444444
Standard Error	45.37	120-140	130	5	11.11111111
variance	2262.98	140-160	150	6	13.33333333
Median	144	160-180	17	7	15.55555556
Skewness	0.85	180-200	190	5	11.11111111
Minimum	95	200-220	210	2	4.444444444
Maximum	268	220-240	230	0	0
Count	45	240-260	250	2	4.444444444
		260-280	270	2	4.444444444
			Total	45	

Summer Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	453.111	1-100	50	1	2.222222222
Standard dev.	206.705	100-200	150	4	8.888888889
Standard Error	189.7	200-300	250	6	13.33333333
variance	42726.96	300-400	350	9	20
Median	424	400-500	450	10	22.22222222
Skewness	0.81	500-600	550	7	15.55555556
Minimum	74	600-700	650	3	6.666666667
Maximum	1056	700-800	750	2	4.444444444
Count	45	800-900	850	1	2.222222222
		900-1000	950	1	2.222222222
		1000-1100	1050	1	2.222222222
			Total	45	

No. of Annual Rainy Days

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	114	79-86	82.5	3	6.666666667
Standard dev.	16.20325	86-93	89.5	3	6.666666667
Standard Error	13.23	93-100	96.5	1	2.222222222
variance	262.546	100-107	103.5	6	13.33333333
Median	114	107-114	110.5	10	22.22222222
Skewness	-0.07	114-121	117.5	9	20
Minimum	81	121-128	124.5	6	13.33333333
Maximum	148	128-135	131.5	2	4.444444444
Count	45	125-142	138.5	3	6.666666667
		142-149	145.5	2	4.444444444
			Total	45	

No. of Monsoon Rainy Days

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	76.5555	48-53	50.5	1	2.222222222
Standard dev.	9.983	53-58	55.5	2	4.444444444
Standard Error	8.07	58-63	60.5	2	4.444444444
variance	99.66	63-68	65.5	3	6.666666667
Median	78	68-73	70.5	6	13.33333333
Skewness	-0.55	73-78	75.5	10	22.22222222
Minimum	51	78-83	80.5	13	28.88888889
Maximum	94	83-88	85.5	2	4.444444444
Count	45	88-93	90.5	4	8.888888889
		93-98	95.5	2	4.444444444
			Total	45	

No. of Summer Rainy Days

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	24.6666	5-9	7	2	4.444444444
Standard dev.	7.3854	9-13	11	0	0
Standard Error	6.96	13-17	15	3	6.666666667
variance	54.544	17-21	19	11	24.44444444
Median	24	21-25	23	7	15.55555556
Skewness	0.19	25-29	27	13	28.88888889
Minimum	8	29-33	31	3	6.666666667
Maximum	42	33-37	35	3	6.666666667
Count	45	37-41	39	2	4.444444444
		41-45	43	1	2.222222222
			Total	45	

Annual Average Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	76.68	40-47	43.5	1	2.222222222
Standard dev.	15.67	47-54	50.5	2	4.444444444
Standard Error	14.24	54-61	57.5	2	4.444444444
variance	245.73	61-68	64.5	11	24.44444444
Median	75.5	68--75	71.5	6	13.33333333
Skewness	0.35	75-82	78.5	7	15.55555556
Minimum	44.8	82-89	85.5	5	11.11111111
Maximum	108.4	89-96	92.5	5	11.11111111
Count	45	96-103	99.5	2	4.444444444
		103-110	106.5	4	8.888888889
			Total	45	

Table B.3 : Statistical characteristics and frequency table of Rainfall for Tangail (1962-1995)

Annual Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	1777	650-900	775	2	5.882352941
Standard dev.	536.2	900-1150	1025	1	2.941176471
Standard Error	393.84	1150-1400	1275	4	11.76470588
variance	287510.4	1400-1650	1525	10	29.41176471
Median	1687	1650-1900	1775	8	23.52941176
Skewness	0.61	1900-2150	2025	2	5.882352941
Minimum	650	2150-2400	2275	3	8.823529412
Maximum	3079	2400-2650	2525	2	5.882352941
Count	34	2650-2900	2775	0	0
		2900-3150	3025	2	5.882352941
			Total	34	

Monsoon Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	1214.7	300-500	400	1	2.857142857
Standard dev.	410.144	500-700	600	1	2.857142857
Standard Error	312.48	700-900	800	3	8.571428571
variance	168218.1	900-1100	1000	10	28.57142857
Median	1125.48	1100-1300	1200	8	22.85714286
Skewness	0.75	1300-1500	1400	5	14.28571429
Minimum	331	1500-1700	1600	3	8.571428571
Maximum	2421	1700-1900	1800	1	2.857142857
Count	35	1900-2100	2000	2	5.714285714
		2100-2300	2200	0	0
		2300-2500	2400	1	2.857142857
			Total	35	

One day Annual Max. Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	121.371	30-50	40	2	5.714285714
Standard dev.	48.665	50-70	60	1	2.857142857
Standard Error	42.74	70-90	80	8	22.85714286
variance	2368.28	90-110	100	8	22.85714286
Median	106	110-130	120	4	11.42857143
Skewness	0.85	130-150	140	5	14.28571429
Minimum	35	150-170	160	1	2.857142857
Maximum	35	170-190	180	2	5.714285714
Count	251	190-210	200	2	5.714285714
		210-230	220	1	2.857142857
		230-250	230	1	2.857142857
			Total	35	

Summer Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	353.5	20-80	50	1	2.941176471
Standard dev.	153.994	80-140	110	3	8.823529412
Standard Error	138.71	140-200	170	1	2.941176471
variance	23714.15	200-260	230	4	11.76470588
Median	350.3	260-320	290	6	17.64705882
Skewness	-0.07	320-380	350	6	17.64705882
Minimum	22	380-440	410	4	11.76470588
Maximum	653	440-500	470	4	11.76470588
Count	34	500-560	530	2	5.882352941
		560-620	590	2	5.882352941
		620-680	650	1	2.941176471
			Total	34	

No. of Annual Rainy Days

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	104.71	50-60	55	2	5.882352941
Standard dev.	19.38	60-70	65	1	2.941176471
Standard Error	18.33	70-80	75	0	0
variance	375.55	80-90	85	2	5.882352941
Median	102.5	90-100	95	8	23.52941176
Skewness	-0.42	100-110	105	7	20.58823529
Minimum	57	110-120	115	9	26.47058824
Maximum	146	120-130	125	2	5.882352941
Count	34	130-140	135	2	5.882352941
		140-150	145	1	2.941176471
			Total	34	

No. of Monsoon Rainy Days

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	71.457	36-42	39	1	2.857142857
Standard dev.	12.358	42-48	45	1	2.857142857
Standard Error	11.341	48-54	51	2	5.714285714
variance	152.72	54-60	57	1	2.857142857
Median	71	60-66	63	5	14.28571429
Skewness	-0.49	66-72	69	9	25.71428571
Minimum	39	72-78	75	6	17.14285714
Maximum	96	78-84	81	5	14.28571429
Count	35	84-90	87	3	8.571428571
		90-96	93	2	5.714285714
			Total	35	

No. of Summer Rainy Days

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	22.24	5-9	7	2	5.882352941
Standard dev.	8.072	9-13	11	4	11.76470588
Standard Error	7.97	13-17	15	4	11.76470588
variance	65.16	17-21	19	2	5.882352941
Median	23	21-25	23	12	35.29411765
Skewness	0.091	25-29	27	4	11.76470588
Minimum	8	29-33	31	2	5.882352941
Maximum	41	33-37	35	3	8.823529412
Count	34	37-41	39	1	2.941176471
			Total	34	

Annual Average Rainfall (mm)

Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	58.155	20-28	24	1	2.941176471
Standard dev.	17.576	28-36	32	1	2.941176471
Standard Error	12.893	36-44	40	4	11.76470588
variance	308..916	44-52	48	7	20.58823529
Median	55.23	52-60	56	10	29.41176471
Skewness	0.6	60-68	64	3	8.823529412
Minimum	21.2	68-76	72	2	5.882352941
Maximum	100.6	76--84	80	3	8.823529412
Count	34	84-92	88	1	2.941176471
		92--100	96	2	5.882352941
			Total	34	

Table B.4 : Statistical characteristics and frequency table of Temperature for Dhaka city (1953-1995)

Annual Av. Max. Temperature (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	30.4	29.5-29.7	29.6	1	2.325581395
Standard dev.	0.5045	29.7-29.9	29.8	4	9.302325581
Standard Error	0.4504	29.9-30.1	30	8	18.60465116
variance	0.25452	30.1-30.3	30.2	10	23.25581395
Median	30.3	30.3-30.5	30.4	8	18.60465116
Skewness	0.88	30.5-30.7	30.6	2	4.651162791
Minimum	29.6	30.7-30.9	30.8	3	6.976744186
Maximum	31.6	30.9-31.1	31	2	4.651162791
Count	43	31.1-31.3	31.2	2	4.651162791
		31.3-31.5	31.4	2	4.651162791
		31.5-31.7	31.6	1	2.325581395
			Total	43	

Annual Av. Min. Temperature (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	21.3	20.3-20.5	20.4	1	2.325581395
Standard dev.	0.5	20.5-20.7	20.6	2	4.651162791
Standard Error	0.2985	20.7-20.9	20.8	9	20.93023256
variance	0.25	20.9-21.1	21	4	9.302325581
Median	21.25	21.1-21.3	21.2	8	18.60465116
Skewness	0.33	21.3-21.5	21.4	7	16.27906977
Minimum	20.5	21.5-21.7	21.6	5	11.62790698
Maximum	22.2	21.7-21.9	21.8	2	4.651162791
Count	43	21.9-22.1	22	3	6.976744186
		22.1-22.3	22.2	2	4.651162791
			Total	43	

Summer Av. Max. Temperature (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	33.2	31.0-31.4	62.5	1	2.325581395
Standard dev.	0.81	31.4-31.8	87.5	2	4.651162791
Standard Error	0.8	31.8-32.2	112.5	3	6.976744186
variance	0.6561	32.2-32.6	137.5	5	11.62790698
Median	33.17	32.6-33.0	162.5	6	13.95348837
Skewness	-0.06	33.0-33.4	187.5	10	23.25581395
Minimum	31.3	33.4-33.8	212.5	9	20.93023256
Maximum	35	33.8-34.2	237.5	4	9.302325581
Count	43	34.2-34.6	262.5	1	2.325581395
		34.6-35	287.5	2	4.651162791
			Total	43	

Summer Av. Min. Temperature (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	22.8	21.1-21.4	21.25	1	2.325581395
Standard dev.	0.62	21.4-21.7	21.55	2	4.651162791
Standard Error	0.5979	21.7-22	21.85	3	6.976744186
variance	0.3844	22-22.3	22.15	6	13.95348837
Median	22.8	22.3-22.6	22.45	6	13.95348837
Skewness	-0.18	22.6-22.9	22.75	7	16.27906977
Minimum	21.4	22.9-23.2	23.05	9	20.93023256
Maximum	23.9	23.2-23.5	23.35	5	11.62790698
Count	43	23.5-23.8	23.65	3	6.976744186
		23.8-24.1	23.95	1	2.325581395
			Total	43	

Winter Av. Max. Temperature (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	26.6	24.7-25.0	24.85	1	2.43902439
Standard dev.	0.73	25.0-25.3	25.15	0	0
Standard Error	0.7186	25.3-25.6	25.45	1	2.43902439
variance	0.5329	25.6-25.9	25.75	4	9.756097561
Median	26.4	25.9-26.2	26.05	6	14.63414634
Skewness	0.49	26.2-26.5	26.35	14	34.14634146
Minimum	24.8	26.5-26.8	26.65	4	9.756097561
Maximum	28.3	26.8-27.1	26.95	1	2.43902439
Count	43	27.1-27.4	27.25	4	9.756097561
		27.4-27.7	27.55	3	7.317073171
		27.7-28.0	27.85	1	2.43902439
		28.0-28.3	28.15	2	4.87804878
			Total	41	

Av. Winter Min. Temperature (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	13.7	11.2-11.6	11.4	1	2.43902439
Standard dev.	0.97817	11.6-12.0	11.8	1	2.43902439
Standard Error	0.6777	12.0-12.4	12.2	1	2.43902439
variance	0.9568	12.4-12.8	12.6	3	7.317073171
Median	13.6	12.8-13.2	13	8	19.51219512
Skewness	-0.07	13.2-13.6	13.4	9	21.95121951
Minimum	11.3	13.6-14.0	13.8	5	12.19512195
Maximum	15.8	14.0-14.4	14.2	4	9.756097561
Count	43	14.4-14.8	14.6	1	2.43902439
		14.8-15.2	15	6	14.63414634
		15.2-15.6	15.4	1	2.43902439
		15.6-16.0	15.8	1	2.43902439
			Total	41	

Annual Mean Temperature (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	25.9	25.1-25.3	25.2	1	2.325581395
Standard dev.	0.4	25.3-25.5	25.4	6	13.95348837
Standard Error	0.3088	25.5-25.7	25.6	9	20.93023256
variance	0.16	25.7-25.9	25.8	10	23.25581395
Median	25.76	25.9-26.1	26	5	11.62790698
Skewness	0.9	26.1-26.3	26.2	5	11.62790698
Minimum	25.3	26.3-26.5	26.4	2	4.651162791
Maximum	26.9	26.5-26.7	26.6	3	6.976744186
Count	43	26.7-26.9	26.8	2	4.651162791
			Total	43	

One Day Annual Min. Temp. (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	8.1186	5.5-6.0	5.75	1	2.325581395
Standard dev.	1.406	6.0-60.5	6.25	5	11.62790698
Standard Error	1.223	6.5-7.0	6.75	5	11.62790698
variance	1.9853	7.0-7.5	7.25	7	16.27906977
Median	7.8	7.5-8.0	7.75	4	9.302325581
Skewness	0.39256	8.0-8.5	8.25	2	4.651162791
Minimum	5.6	8.5-9.0	8.75	10	23.25581395
Maximum	11.6	9.0-9.5	9.25	1	2.325581395
Count	43	9.5-10.0	9.75	5	11.62790698
		10.0-10.5	10.25	0	0
		10.5-11.0	10.75	2	4.651162791
		11.0-11.5	11.25	0	0
		11.5-12.0	11.75	1	2.325581395
			Total	43	

One Day Annual Max. Temp. (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	37.574	35.3-35.8	35.33	3	6.976744186
Standard dev.	1.0228	35.8-36.3	36.05	0	0
Standard Error	0.9782	36.3-36.8	36.55	4	9.302325581
variance	1.046	36.8-37.3	37.05	11	25.58139535
Median	37.6	37.3-37.8	37.55	17	39.53488372
Skewness	0.554	37.8-38.3	38.05	2	4.651162791
Minimum	35.3	38.3-38.8	38.55	0	0
Maximum	40.8	38.8-39.3	39.05	3	6.976744186
Count	43	39.3-39.8	39.55	2	4.651162791
		39.8-40.3	40.05	0	0
		40.3-40.8	40.55	1	2.325581395
			Total	43	

Table B.5 : Statistical characteristics and frequency table of Temperature for Mymensingh (1951-1995)

Annual Av. Max. Temperature (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	30	29.1-29.3	29.2	1	2.222222222
Standard dev.	0.3	29.3-29.5	29.4	1	2.222222222
Standard Error	0.3116	29.5-29.7	29.6	8	17.77777778
variance	0.09	29.7-29.9	29.8	9	20
Median	29.96	29.9-30.1	30	12	26.66666667
Skewness	0.34	30.1-30.3	30.2	7	15.55555556
Minimum	29.3	30.3-30.5	30.4	5	11.11111111
Maximum	30.9	30.5-30.7	30.6	1	2.222222222
Count	45	30.7-30.9	30.8	1	2.222222222
			Total	45	

Annual Av. Min. Temperature (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	20.7	19.6-19.8	19.7	1	2.222222222
Standard dev.	0.3	19.8-20.0	19.9	0	0
Standard Error	0.313	20.0-20.2	20.1	1	2.222222222
variance	0.09	20.2-20.4	20.3	8	17.77777778
Median	20.69	20.4-20.6	20.5	9	20
Skewness	-0.38	20.6-20.8	20.7	15	33.33333333
Minimum	19.6	20.8-21.0	20.9	8	17.77777778
Maximum	21.4	21.0-21.2	21.1	1	2.222222222
Count	45	21.2-21.4	21.3	2	4.444444444
			Total	45	

Summer Av. Max. Temperature (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	32.1	29.8-30.2	30	2	4.444444444
Standard dev.	0.9515	30.2-30.6	30.4	1	2.222222222
Standard Error	0.6818	30.6-31.0	30.8	4	8.888888889
variance	0.9053	31.0-31.4	31.2	1	2.222222222
Median	32	31.4-31.8	31.6	9	20
Skewness	-0.18	31.8-32.2	32	9	20
Minimum	30.1	32.2-32.6	32.4	4	8.888888889
Maximum	34	32.6-33.0	32.8	7	15.55555556
Count	45	33.0-33.4	33.2	5	11.11111111
		33.4-33.8	33.6	1	2.222222222
		33.8-34.2	34	2	4.444444444
			Total	45	

Summer Av. Min. Temperature (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	21.4	19.4-19.7	19.55	1	2.222222222
Standard dev.	0.6421	19.7-20.0	19.85	0	0
Standard Error	0.633	20.0-20.3	20.15	2	4.444444444
variance	0.4122	20.3-20.6	20.45	3	6.666666667
Median	21.53	20.6-20.9	20.75	3	6.666666667
Skewness	-0.79	20.9-21.2	21.05	7	15.55555556
Minimum	19.5	21.2-21.5	21.35	7	15.55555556
Maximum	22.7	21.5-21.8	21.65	11	24.44444444
Count	45	21.8-22.1	21.95	8	17.77777778
		22.1-22.4	22.25	2	4.444444444
		22.4-22.7	22.55	1	2.222222222
			Total	45	

Winter Av. Max. Temperature (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	26.2	24.7-25.0	24.85	3	6.976744186
Standard dev.	0.6797	25.0-25.3	25.15	1	2.325581395
Standard Error	0.662	25.3-25.6	25.45	5	11.62790698
variance	0.46199	25.6-25.9	25.75	6	13.95348837
Median	26.1	25.9-26.2	26.05	10	23.25581395
Skewness	0.07	26.2-26.5	26.35	7	16.27906977
Minimum	24.8	26.5-26.8	26.65	3	6.976744186
Maximum	27.8	26.8-27.1	26.95	5	11.62790698
Count	43	27.1-27.4	27.25	2	4.651162791
		27.4-27.8	27.55	1	2.325581395
			Total	43	

Winter Av. Min. Temperature (° C)
Frequency table

Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	13.2	11.5-11.8	11.65	1	2.325581395
Standard dev.	0.59	11.8-12.1	11.95	1	2.325581395
Standard Error	0.5151	12.1-12.4	12.25	0	0
variance	0.3481	12.4-12.7	12.55	6	13.95348837
Median	13.27	12.7-13.0	12.85	7	16.27906977
Skewness	-0.46	13.0-13.3	13.15	12	27.90697674
Minimum	11.7	13.3-13.6	13.45	9	20.93023256
Maximum	14.4	13.6-13.9	13.75	4	9.302325581
Count	43	13.9-14.2	14.05	2	4.651162791
		14.2-14.5	14.35	1	2.325581395
			Total	43	

Annual Mean. Temperature (° C) Frequency table					
Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	25.3	24.7-24.8	25.75	1	2.222222222
Standard dev.	0.257	24.8-24.9	25.85	1	2.222222222
Standard Error	0.2525	24.9-25.0	24.95	1	2.222222222
variance	0.066	25.0-25.1	25.05	6	13.33333333
Median	25.3	25.1-25.2	25.15	8	17.77777778
Skewness	0.08	25.2-25.3	25.25	10	22.22222222
Minimum	24.7	25.3-25.4	25.35	5	11.11111111
Maximum	25.9	25.4-25.5	25.45	2	4.444444444
Count	45	25.5-25.6	25.55	5	11.11111111
		25.6-25.7	25.65	4	8.888888889
		25.7-25.8	25.75	0	0
		25.8-25.9	25.85	2	4.444444444
			Total	45	

One day Annual Min. Temp. (° C) Frequency table					
Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	8.3244	4.0-4.5	4.25	1	2.222222222
Standard dev.	1.4172	4.5-5.0	4.75	0	0
Standard Error	1.427	5.0-5.5	5.25	0	0
variance	2.0087	5.5-6.0	5.75	5	11.11111111
Median	8.5	6.0-6.5	6.25	1	2.222222222
Skewness	-1.1168	6.5-7.0	6.75	0	0
Minimum	4.2	7.0-7.5	7.25	1	2.222222222
Maximum	10.1	7.5-8.0	7.75	6	13.33333333
Count	45	8.0-8.5	8.25	9	20
		8.5-9.0	8.75	6	13.33333333
		9.0-9.5	9.25	9	20
		9.5-10.0	9.75	5	11.11111111
		10.0-10.5	10.25	2	4.444444444
			Total	45	

One day Annual Max. Temp (° C) Frequency table					
Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	37.228	35.3-35.6	35.45	2	4.444444444
Standard dev.	0.657	35.6-35.9	35.75	1	2.222222222
Standard Error	0.6366	35.9-36.2	36.05	2	4.444444444
variance	0.4316	36.2-36.5	36.35	1	2.222222222
Median	37.4	36.5-36.8	36.65	2	4.444444444
Skewness	-1.0851	36.8-37.1	36.95	6	13.33333333
Minimum	35.4	37.1-37.4	37.25	12	26.66666667
Maximum	38.5	37.4-37.7	37.55	16	35.55555556
Count	37.4	37.7-38.0.0	37.85	0	0
		38.0-38.3	38.15	2	4.444444444
		38.3-38.6	38.45	1	2.222222222
			Total	45	

Table B.6 : Statistical characteristics and frequency table of Atmospheric pressure for Dhaka city (1953-1994)

Annual Av. At. Pressure (mb) Frequency table					
Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	1007.7	1006.6-1006.8	1006.7	1	2.380952381
Standard dev.	0.4785	1006.8-1007.0	1006.9	2	4.761904762
Standard Error	0.377	1007.0-1007.2	1007.1	8	19.04761905
variance	0.2289	1007.2-1007.4	1007.3	2	4.761904762
Median	1007.73	1007.4-1007.6	1007.5	6	14.28571429
Skewness	0.03	1007.6-1007.8	1007.7	7	16.66666667
Minimum	1006.8	1007.8-1008.0	1007.9	4	9.523809524
Maximum	1008.6	1008.0-1008.2	1008.1	7	16.66666667
Count	42	1008.2-1008.4	1008.3	2	4.761904762
		1008.4-1008.6	1008.5	3	7.142857143
		Total		42	

Table B.7 : Statistical characteristics and frequency table of Atmospheric pressure for Mymensingh (1951-1995)

Annual Av. At. Pressure (mb) Frequency table					
Statistics		Class interval	Class mark	Frequency	Rel. Freq (%)
Mean	1008.5	1008.0-1008.1	1008.05	3	6.666666667
Standard dev.	0.328	1008.1-1008.2	1008.15	5	11.11111111
Standard Error	0.323	1008.2-1008.3	1008.25	7	15.55555556
variance	0.1075	1008.3-1008.4	1008.35	4	8.888888889
Median	1008.53	1008.4-1008.5	1008.45	4	8.888888889
Skewness	-0.7	1008.5-1008.6	1008.55	4	8.888888889
Minimum	1008	1008.6-1008.7	1008.65	4	8.888888889
Maximum	1009.1	1008.7-1008.8	1008.75	3	6.666666667
Count	45	1008.8-1008.9	1008.85	4	8.888888889
		1008.9-1009.0	1008.95	6	13.33333333
		1009.0-1009.1	1009.05	1	2.222222222
			Total	45	

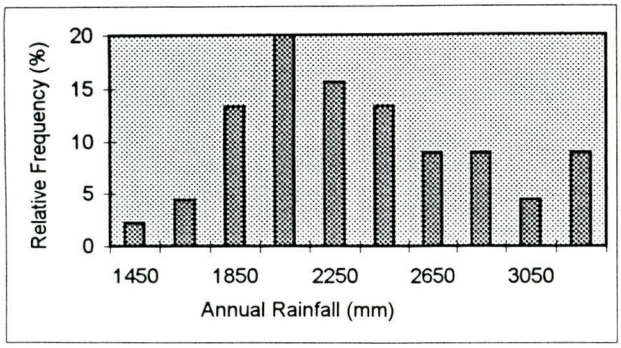
A Sample Calculation : χ^2 - Test

A sample calculation of Chi-square goodness- of- fit is shown in the following Table B-8 for the annual rainfall of Dhaka for the period 1953-1995. A null hypothesis is proposed that the annual rainfall data (1953-1995) are normally distributed with mean 2055 mm and standard deviation 390.04 mm respectively. Table B-8 gives the standard variates Z_i for the bounds of each interval, the probability that the variable Z is less than Z_i, the expected probabilities for each interval, the expected and observed frequencies and the χ^2 values. Test statistic has a computed value of 9.05. Here degree of freedom was 7 for the test statistic. 1 degree of freedom was lost for n, while 2 were lost for the mean and standard deviation which were obtained from the 43 observations. At 10% level of significance, the critical χ^2 value is 12. So the null hypothesis H_0 is accepted which means that the annual rainfall data (1953-1995) are normally distributed with mean = 2055 mm and standard deviation = 390.04 mm.

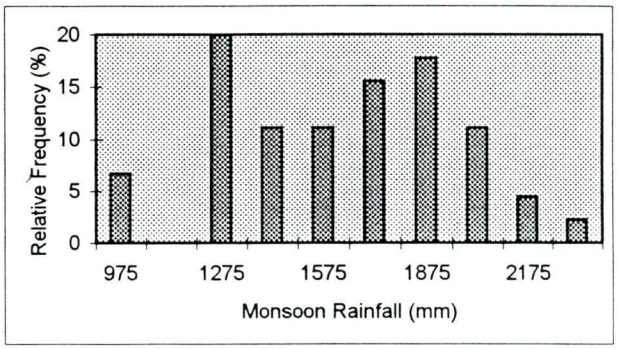
Table B-8 : Sample calculation of annual rainfall data (1953-1995) for Chi-square goodness - of -fit test for normality.

Class interval	Zi	P (Z < Zi)	Expected Probability Y	Expected frequency E_i	Observed frequency O_i	$\frac{(O_i - E_i)^2}{E_i}$
1150-1350	-2.06	0.0197	0.0197	0.8471	2	1.57
1350-1550	-1.55	0.0606	0.0409	1.7587	2	0.03
1550-1750	-1.04	0.1492	0.0886	3.8098	4	0.009
1750-1950	-0.53	0.2981	0.1489	6.4027	10	2.02
1950-2150	-0.012	0.4560	0.1579	6.7897	8	0.22
2150-2350	+0.50	0.6915	0.2355	10.1265	7	0.97
2350-2550	1.01	0.8438	0.1523	6.5489	7	0.03
2550-2750	1.53	0.9370	0.0932	4.0076	0	4.0
2750-2950	2.04	0.9793	0.0423	1.8189	2	0.02
2950-3150	2.55	0.9946	0.0153	0.6579	1	0.08
				43	43	9.05

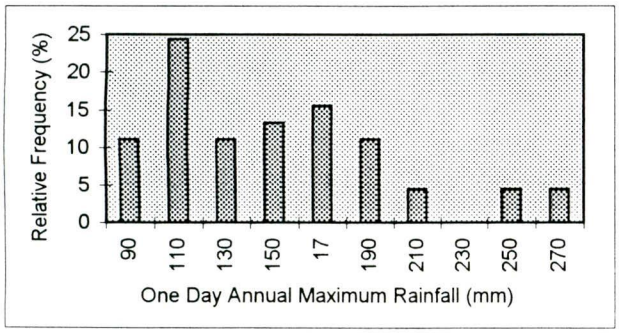
APPENDIX- C : FIGURES



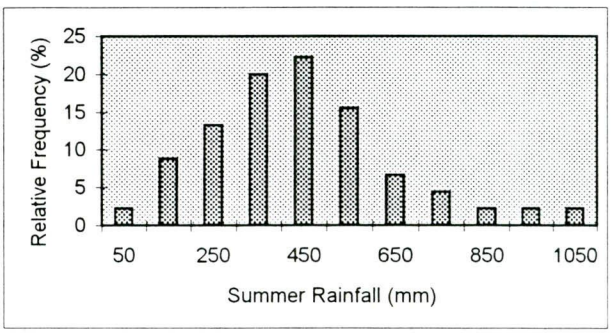
(a) Annual rainfall



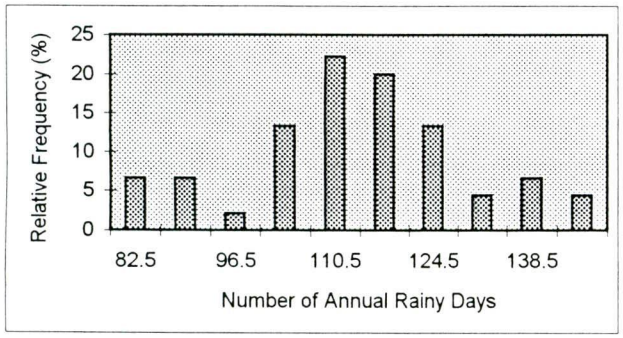
(b) Monsoon rainfall



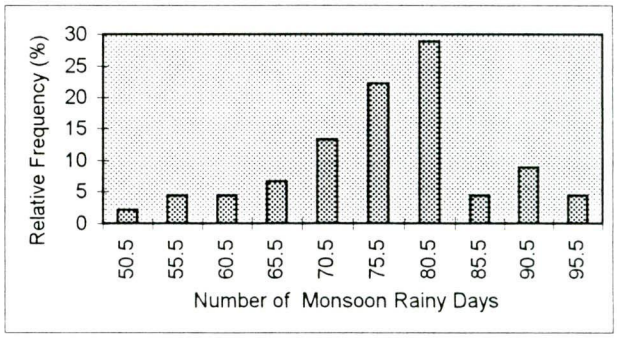
(c) One day annual maximum rainfall



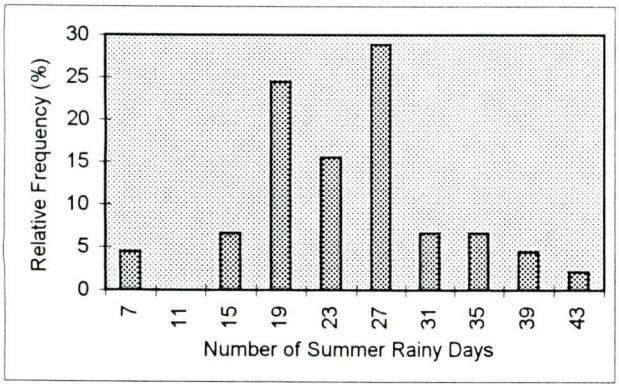
(d) Summer rainfall



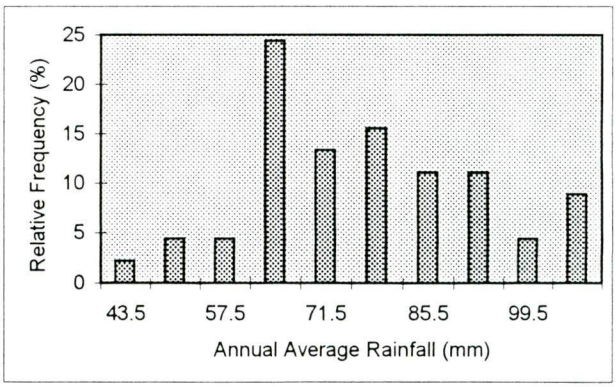
(e) Number of annual rainy days



(f) Number of monsoon rainy days

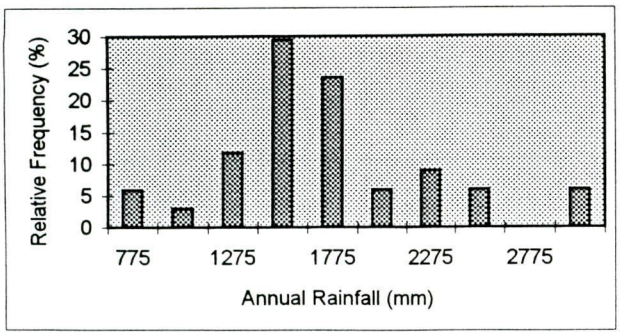


(g) Number of Summer rainy days

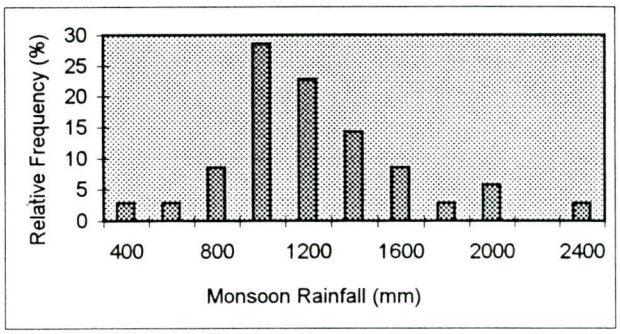


(h) Annual average rainfall

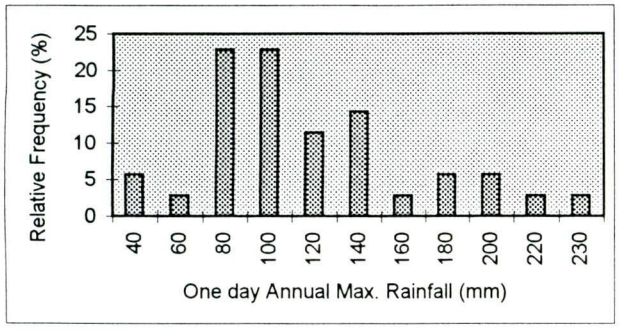
Figure C.1 : Frequency histogram of different rainfall series of Mymensingh (1951-1995)



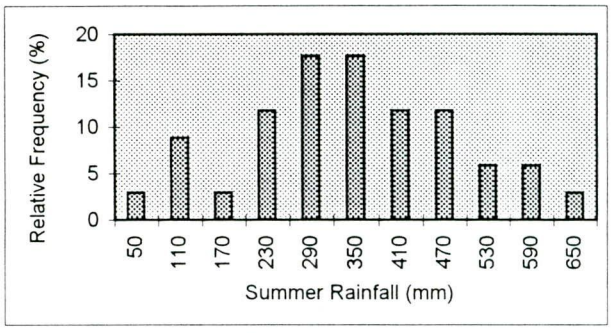
(a) Annual rainfall



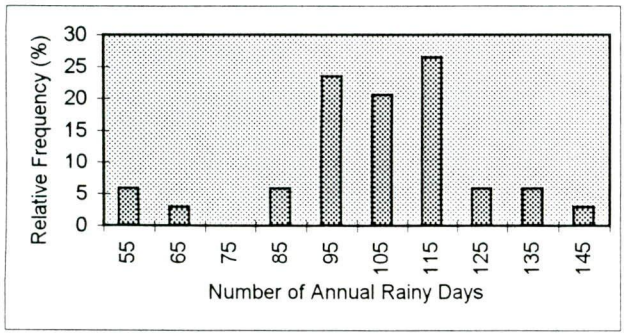
(b) Monsoon rainfall



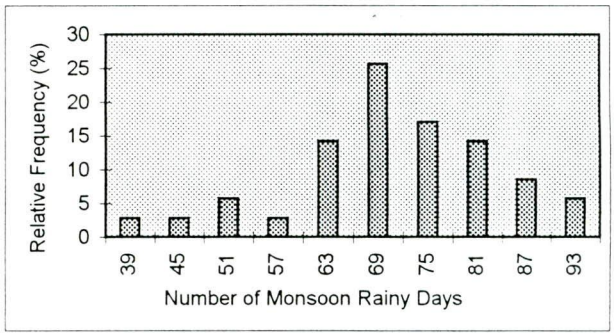
(c) One day annual maximum rainfall



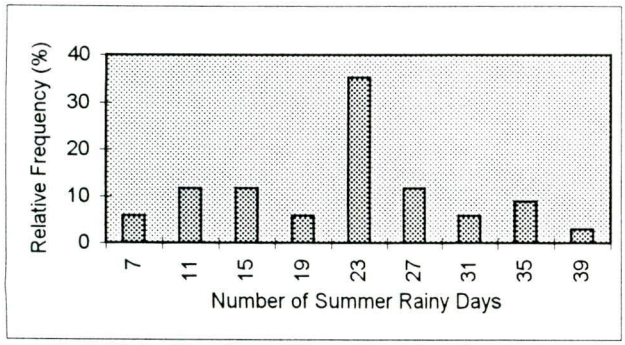
(d) Summer rainfall



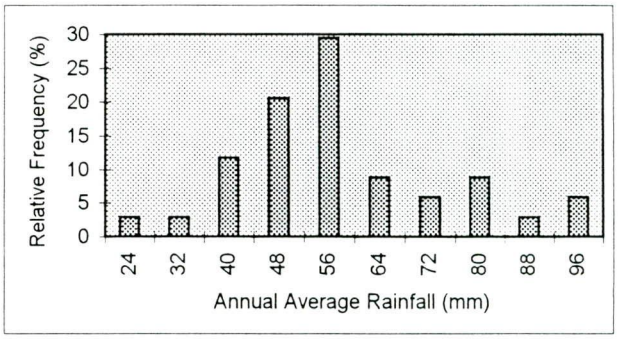
(e) Number of annual rainy days



(f) Number of monsoon rainy days

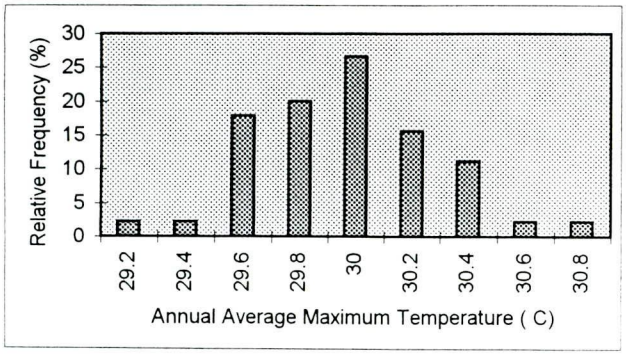


(g) Number of Summer rainy days

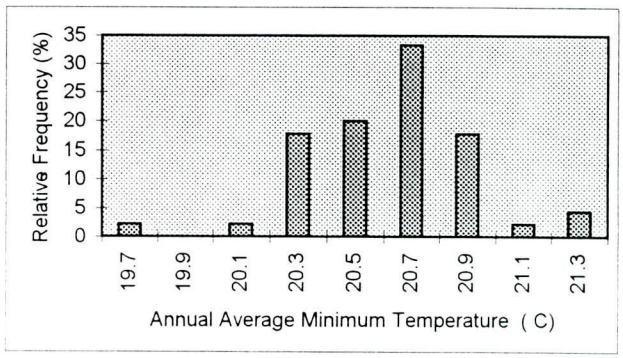


(h) Annual average rainfall

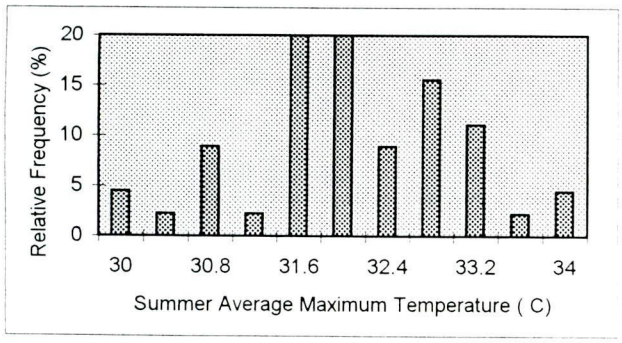
Figure C.2 : Frequency histogram of different rainfall series of Tangail (1962-1995)



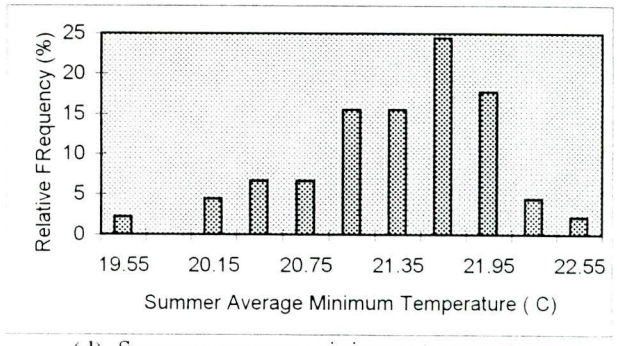
(a) Annual average maximum temperature



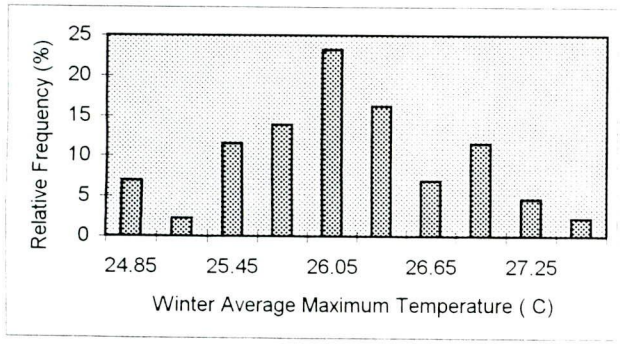
(b) Annual average minimum temperature



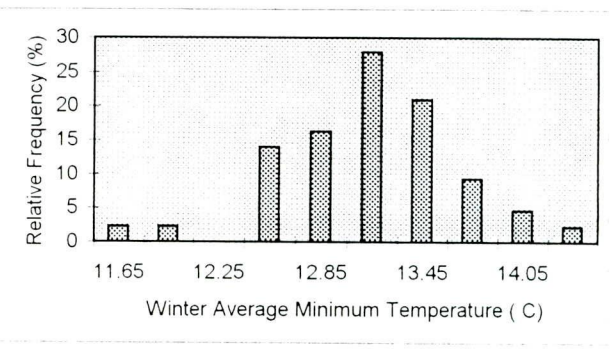
(c) Summer average maximum temperature



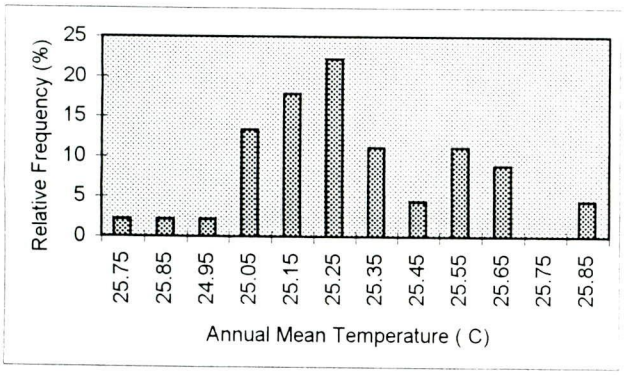
(d) Summer average minimum temperature



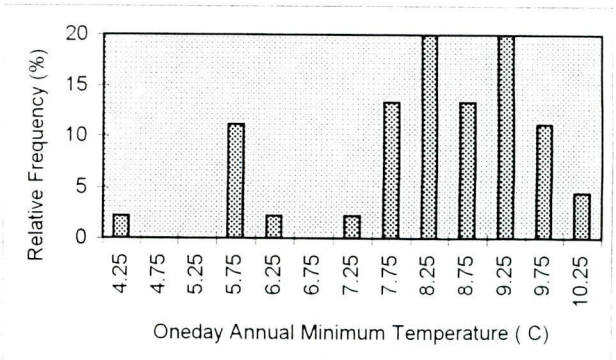
(e) Winter average maximum temperature



(f) Winter average minimum temperature

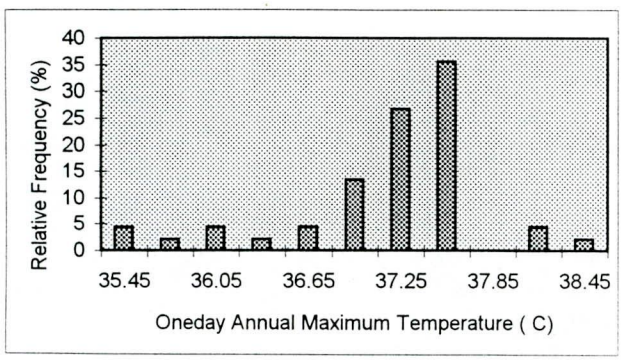


(g) Annual mean temperature



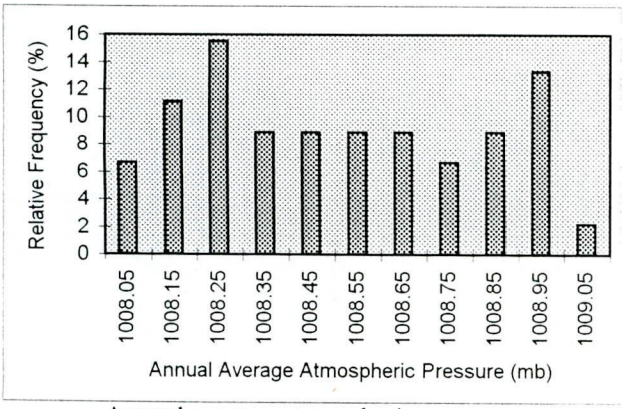
(h) One day annual minimum temperature

Figure C.3 : Frequency histogram of temperature series of Mymensingh (1951-1995)



(i) One day annual maximum temperature

Figure C.3 : Frequency histogram of temperature series of Mymensingh (1951-1995)



Annual average atmospheric pressure

Figure C.4 : Frequency histogram of annual atmospheric pressure series of Mymensingh (1951-1995)

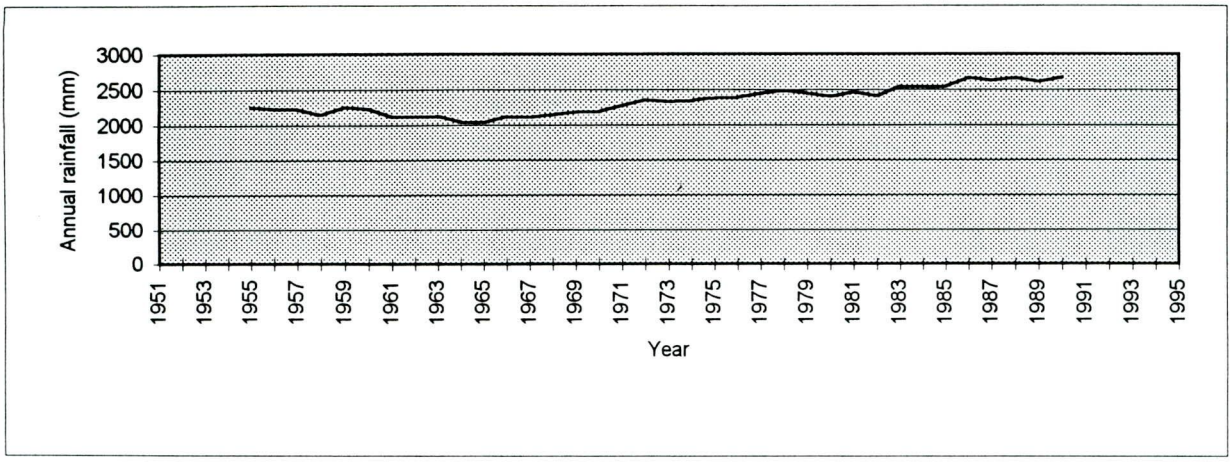


Figure a : 10-year moving average of annual rainfall in Mymensingh for years (1951-1995)

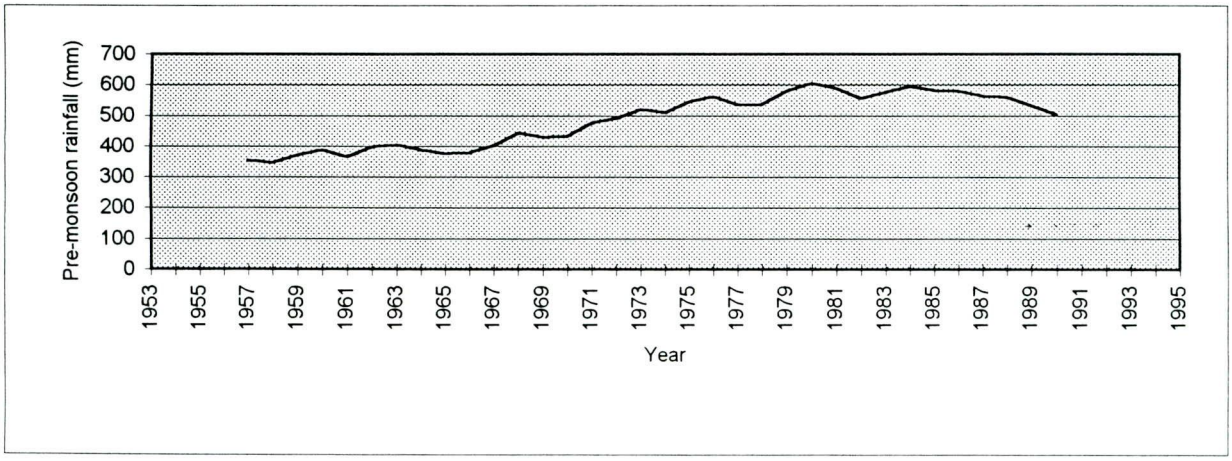


Figure b : 10-year moving average of Summer rainfall in Mymensingh for years (1951-1995)

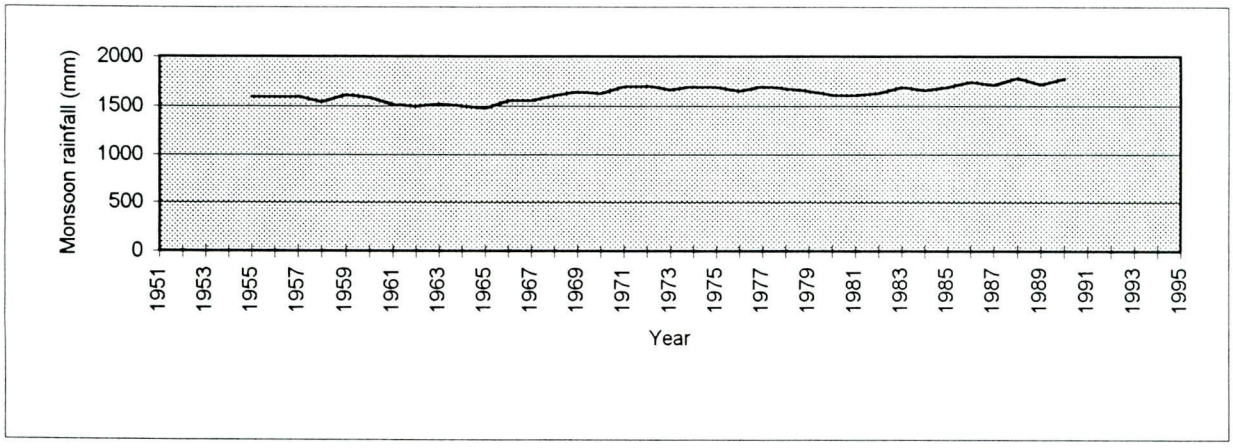


Figure c : 10-year moving average of monsoon rainfall in Mymensingh for years (1951-1995)

Figure C.5 : Trend of 10-year moving average of Annual rainfall, Summer rainfall and Monsoon rainfall for Mymensingh for 45 years period (1951-1995)

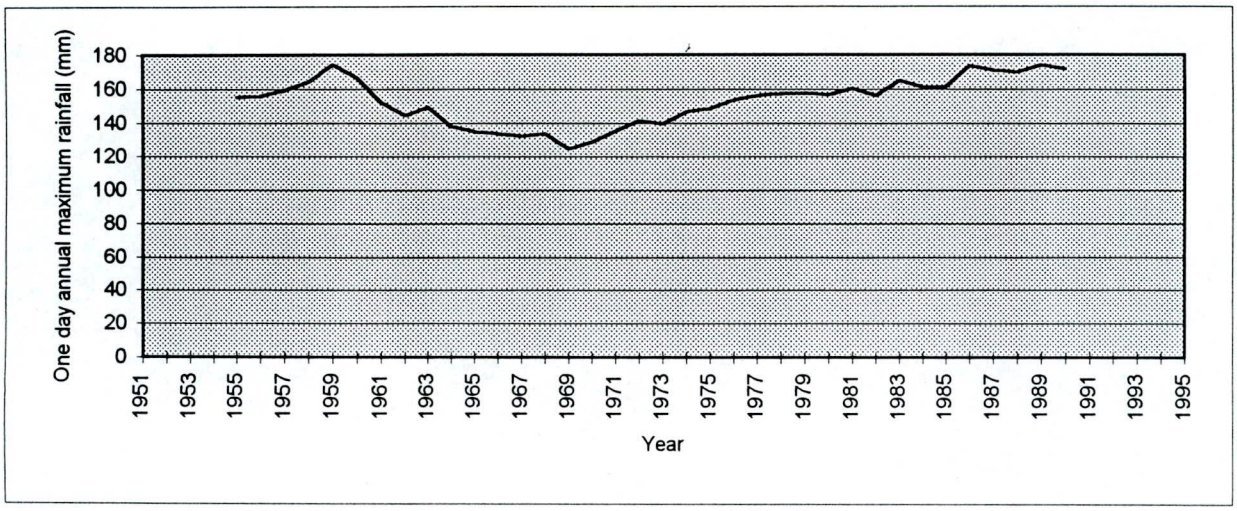


Figure C.6 : Trend of 10-year moving average of one day annual maximum rainfall in Mymensingh for 45 years (1951-1995)

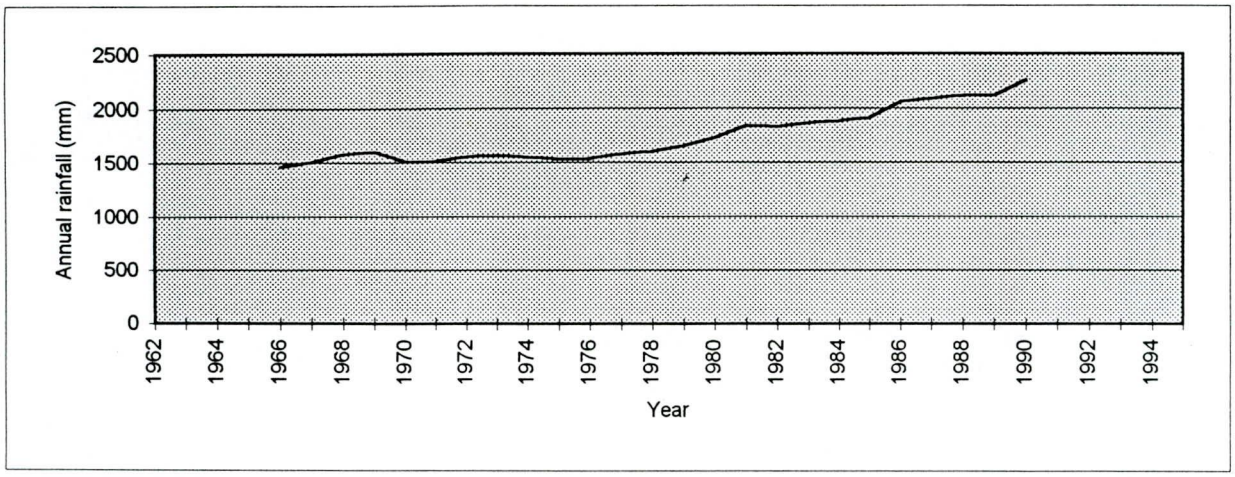


Figure a : 10-year moving average of annual rainfall in Tangail for years (1962-1995)

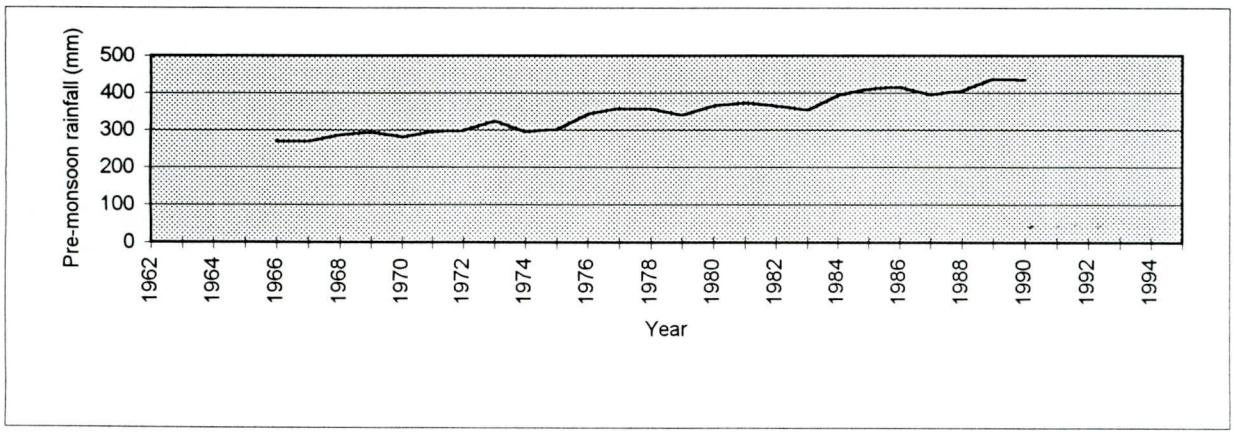


Figure b : 10-year moving average of Summer rainfall in Tangail for years (1962-1995)

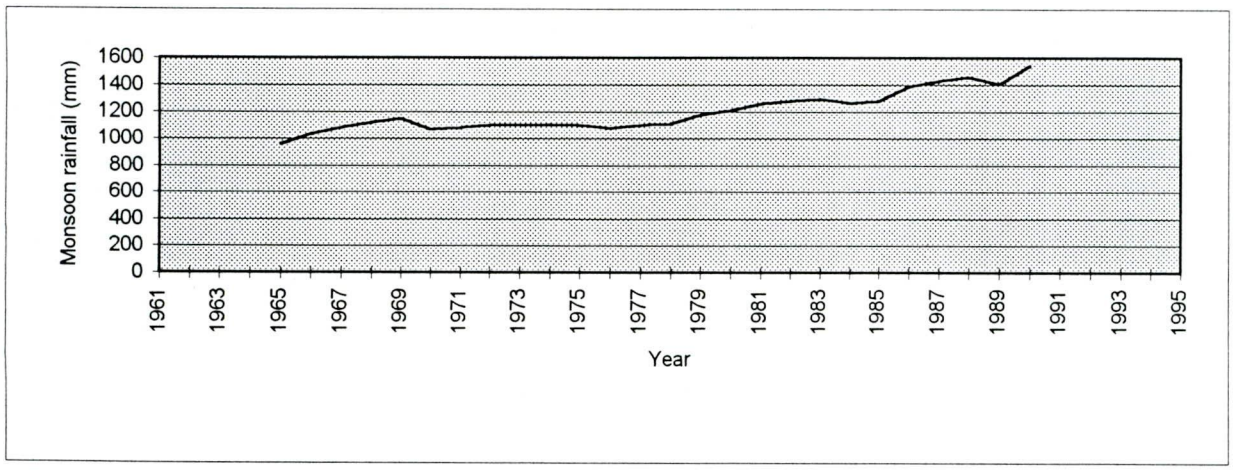


Figure c : 10-year moving average of monsoon rainfall in Tangail for years (1961-1995)

Figure C.7 : Trend of 10-year moving average of Annual rainfall, Summer rainfall and Monsoon rainfall for Tangail for 34 years period (1962-1995)

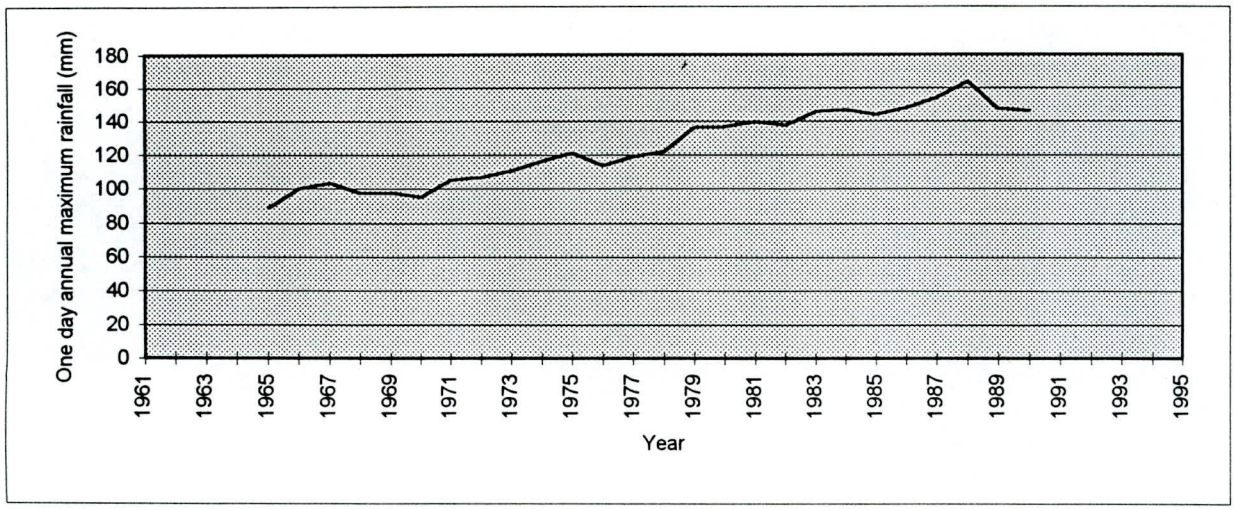


Figure C.8 : Trend of 10-year moving average of one day annual maximum rainfall in Tangail for 35 years (1961-1995)

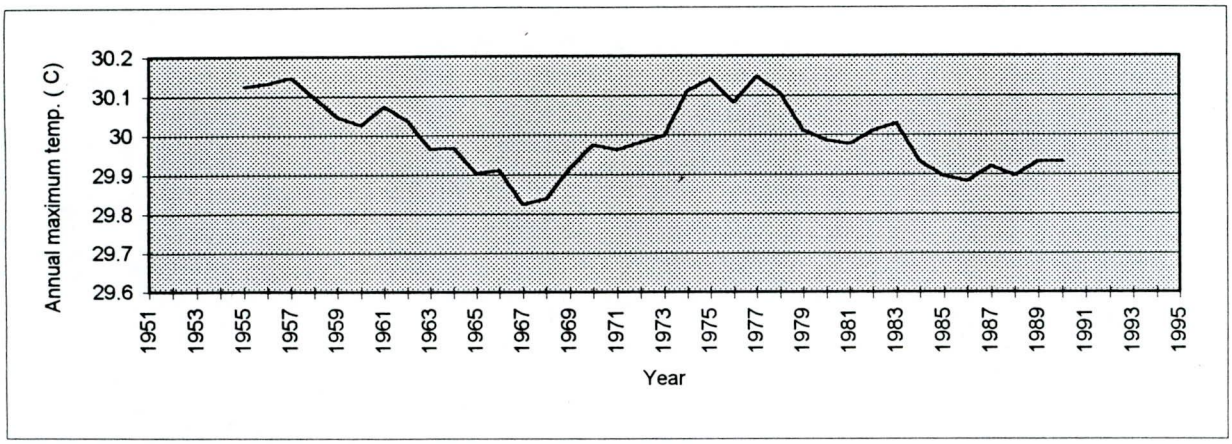


Figure a : 10-year moving average of annual average maximum temperature in Mymensingh for 45 years (1951-1995)

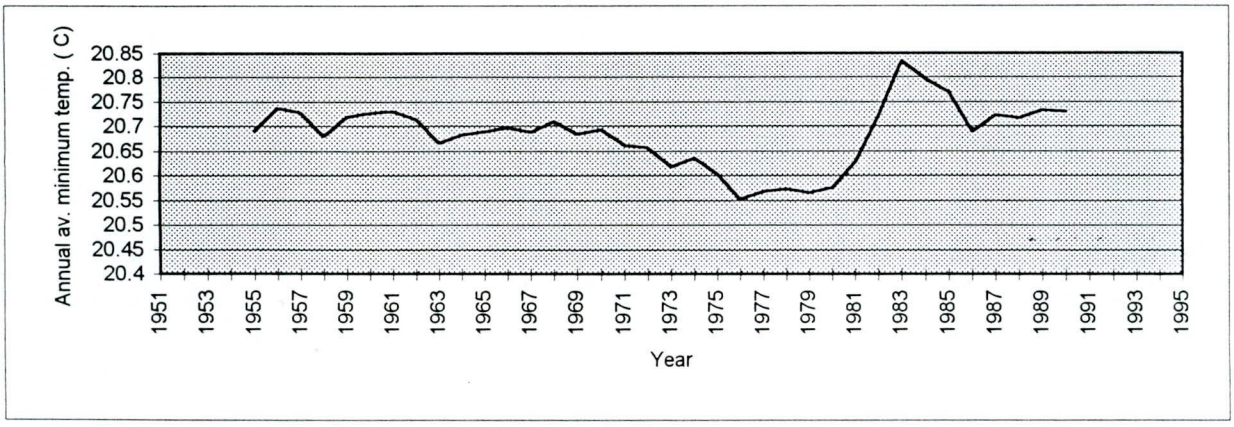


Figure b : 10-year moving average of annual average minximum temperature in Mymensingh for 45 years (1951-1995)

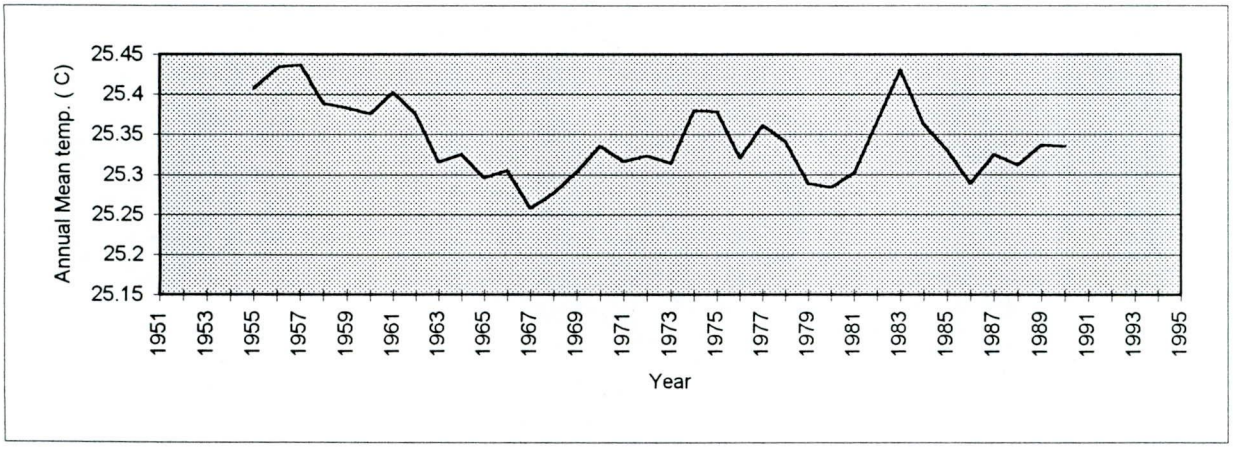


Figure c : 10-year moving average of annual mean temperature in Mymensingh for 45 years (1951-1995)

Figure C.9 : Trend of 10-year moving average of annual average maximum, annual average minimum and annual mean temperature for Mymensingh for 45 years period (1951-1995)

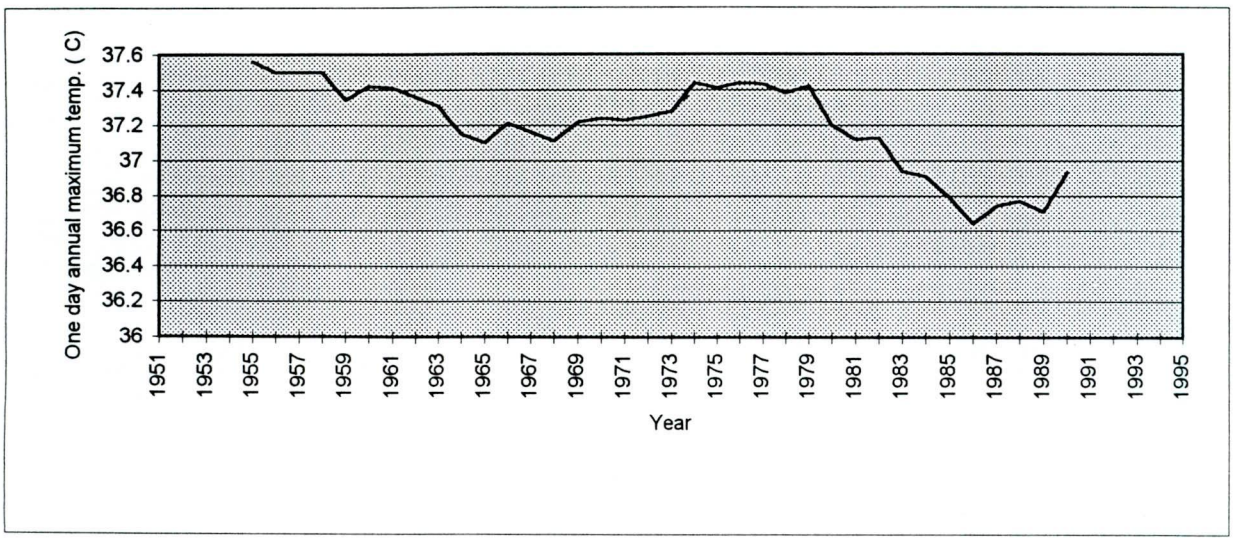


Figure a : 10-year moving average of one day annual maximum temperature in Mymensingh for 45 years (1951-1995)

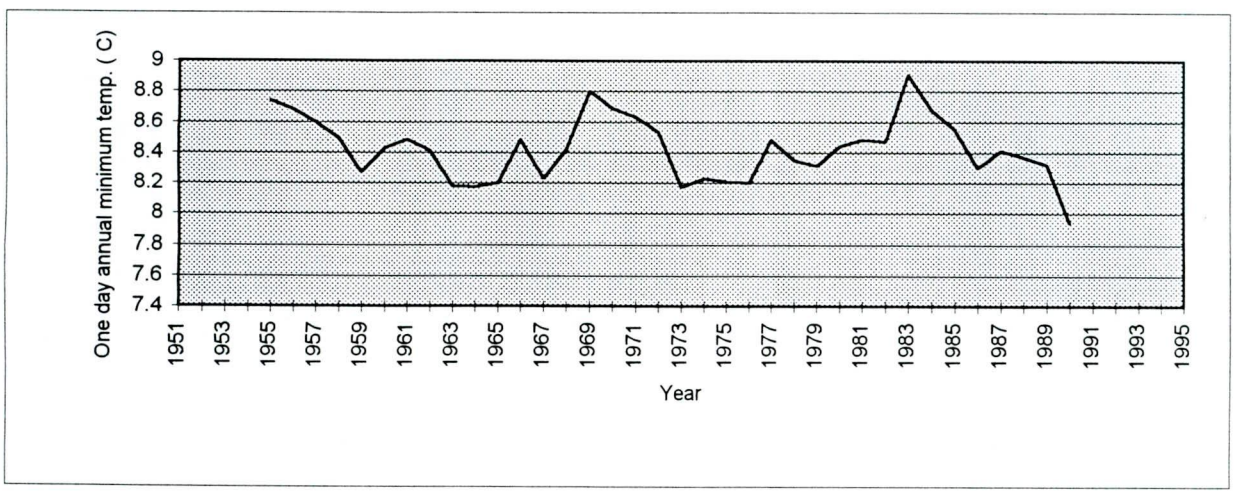


Figure b : 10-year moving average of one day annual minimum temperature in Mymensingh for 45 years (1951-1995)

Figure C.10 : Trend of 10-year moving average of one day annual maximum and one day annual minimum temperature in Mymensingh for 45 years (1951-1995)

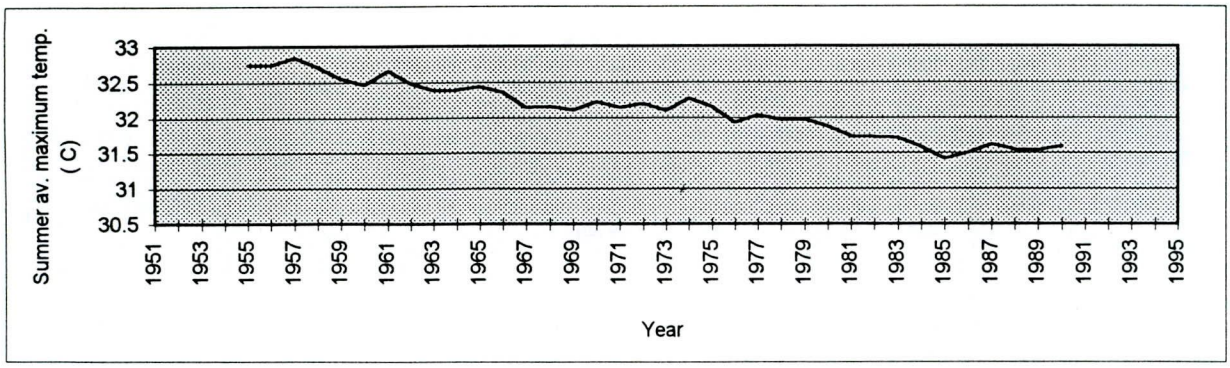


Figure (a) : 10-year moving average of summer average maximum temperature in Mymensingh for 45 years (1951-1995)

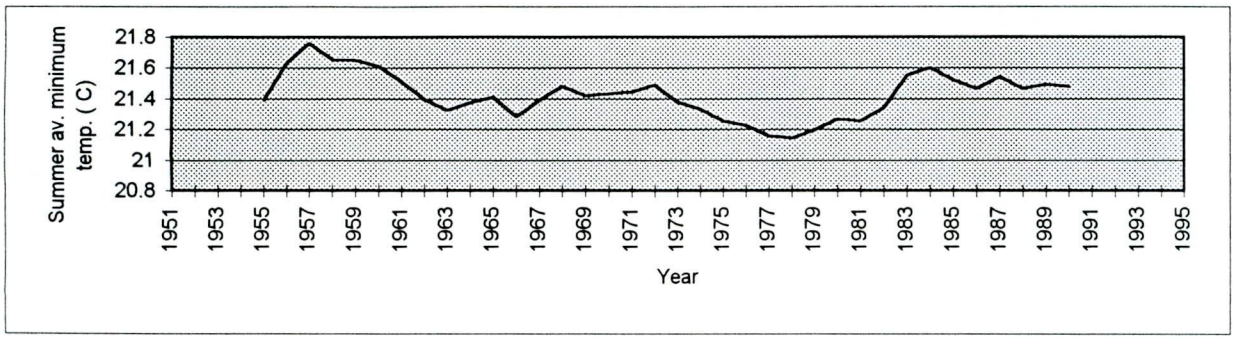


Figure (b) : 10-year moving average of summer average minimum temperature in Mymensingh for 45 years (1951-1995)

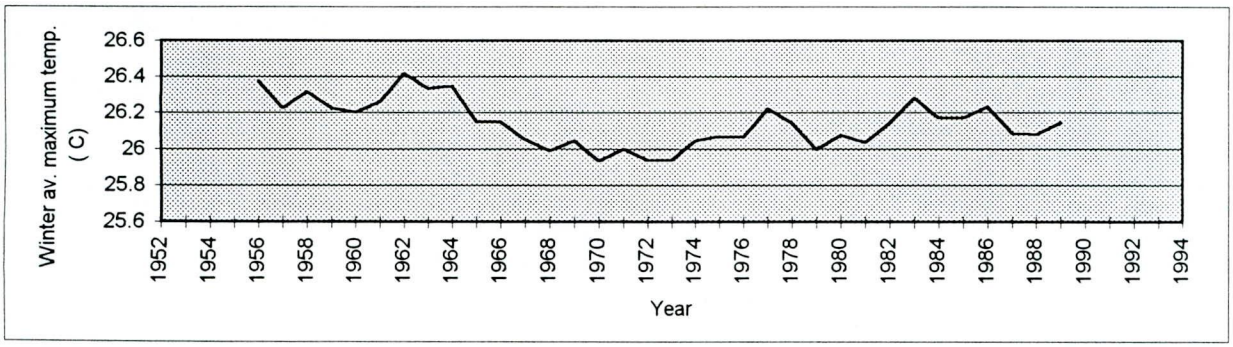


Figure (c) : 10-year moving average of winter average maxnimum temperature in Mymensingh for 43 years (1952-1994)

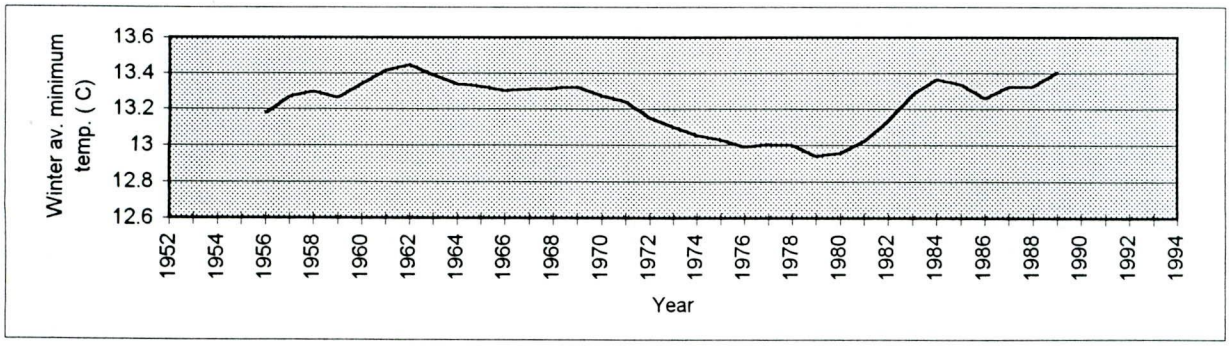


Figure (d) : 10-year moving average of winter average minnimum temperature in Mymensingh for 43 years (1952-1994)

igure C.11 : Trend of 10-year moving average of summer average maximum, summer average minimum, winter average maximum and winter average minimum temperature in Mymensingh for 45 years (1951-1995)

APPENDIX- D : TABLES OF ANNUAL AND SEASONAL DATA

Table D.1 : Annual Rainfall for Dhaka City (1953-1995)

Year	Annual Rainfall in mm	10-year Moving average
1953	1934	
1954	2353	
1955	1543	
1956	2495	
1957	1554	1933
1958	1299	1937
1959	2355	1938
1960	1834	1994
1961	2181	1928
1962	1786	1978
1963	1971	2042
1964	2361	1960
1965	2104	1976
1966	1833	1989
1967	2053	1995
1968	1937	2030
1969	1540	1999
1970	1995	2004
1971	2306	2044
1972	1848	2025
1973	2324	2056
1974	2054	2086
1975	2145	2108
1976	2238	2064
1977	1861	2060
1978	2251	2067
1979	1837	2164
1980	2218	2155
1981	1865	2181
1982	1805	2214
1983	2392	2237
1984	3028	2216
1985	2053	2204
1986	2500	2303
1987	2187	2238
1988	2482	2276
1989	1627	2134
1990	2103	2103
1991	2850	
1992	1159	
1993	2767	
1994	1614	
1995	1743	
Mean	2055	2078
Stdev	390.044219	107.598

Table D.2 : Summer Rainfall for Dhaka City (1953-1995)

Year	Summer Rainfall in mm	10-year Moving average
1953	454	
1954	297	
1955	221	
1956	393	
1957	247	355
1958	310	346
1959	410	371
1960	393	387
1961	444	365
1962	377	397
1963	368	404
1964	550	388
1965	382	374
1966	168	379
1967	569	401
1968	379	443
1969	246	428
1970	260	433
1971	490	477
1972	600	491
1973	784	519
1974	403	509
1975	428	544
1976	610	561
1977	707	534
1978	666	536
1979	137	580
1980	615	604
1981	655	589
1982	339	556
1983	804	576
1984	836	594
1985	671	583
1986	461	580
1987	372	564
1988	869	559
1989	313	533
1990	507	504
1991	628	
1992	178	
1993	756	
1994	573	
1995	349	
Mean	470.2	484
Stdev	191.3691967	85.8569

Table D.3 : Monsoon Rainfall for Dhaka City (1953-1995)

Year	Monsoon Rainfall in mm	10-year Moving average
1953	1404	
1954	1814	
1955	1152	
1956	1898	
1957	1141	1372
1958	703	1373
1959	1358	1332
1960	1379	1370
1961	1661	1316
1962	1214	1340
1963	1411	1410
1964	1407	1393
1965	1526	1381
1966	1363	1373
1967	1374	1364
1968	1410	1347
1969	1188	1354
1970	1252	1345
1971	1581	1358
1972	1132	1299
1973	1241	1305
1974	1475	1329
1975	1430	1331
1976	1499	1276
1977	781	1288
1978	1467	1288
1979	1432	1352
1980	1268	1338
1981	1032	1348
1982	1254	1437
1983	1238	1410
1984	2120	1370
1985	1284	1370
1986	1605	1434
1987	1667	1394
1988	1200	1442
1989	1030	1320
1990	1270	1306
1991	1675	
1992	848	
1993	1717	
1994	905	
1995	1147	
Mean	1348	1355
Stdev	287.453855	42.8222

Table D.4 : One day annual maximum Rainfall for Dhaka City (1953-1995)

Year	ne day annual maximum Rainfall (mm)	10-year Moving average
1953	90	
1954	147	
1955	115	
1956	325	
1957	73	138
1958	58	147
1959	125	144
1960	141	150
1961	185	144
1962	116	149
1963	189	157
1964	114	154
1965	177	155
1966	257	161
1967	125	173
1968	145	171
1969	86	170
1970	152	166
1971	251	157
1972	231	155
1973	168	153
1974	106	155
1975	143	149
1976	163	131
1977	100	123
1978	128	119
1979	108	124
1980	91	118
1981	72	120
1982	146	124
1983	133	124
1984	151	125
1985	92	126
1986	176	131
1987	138	125
1988	135	126
1989	118	118
1990	94	117
1991	123	
1992	90	
1993	140	
1994	74	
1995	83	
Mean	136.6046512	141
Stdev	53.91578068	17.751126

Table D.5 : Number of Rainy days for Dhaka city (1953-1995)

Year	Number of Rainy Days		
	Summer	Monsoon	Annual Total
1953	29	85	128
1954	21	85	124
1955	23	86	121
1956	31	86	135
1957	20	72	104
1958	19	76	108
1959	23	82	128
1960	18	85	112
1961	19	82	113
1962	23	82	129
1963	26	77	119
1964	32	75	129
1965	13	91	119
1966	22	85	127
1967	25	80	115
1968	29	82	124
1969	23	82	115
1970	20	84	125
1971	17	79	115
1972	20	67	95
1973	36	82	141
1974	17	66	92
1975	25	80	126
1976	28	74	117
1977	43	74	137
1978	38	75	127
1979	16	68	98
1980	40	95	152
1981	37	76	129
1982	28	71	111
1983	30	70	122
1984	28	99	140
1985	33	91	133
1986	30	82	129
1987	24	82	115
1988	35	84	139
1989	18	73	104
1990	34	77	129
1991	33	77	132
1992	16	64	96
1993	33	81	139
1994	24	66	102
1995	14	75	107
Mean	25.8837209	79.186047	120.976744
Stdev	7.49669547	7.7128705	13.8228389

Table D.6 : Annual Rainfall for Mymensingh (1951-1995)

Year	Annual Rainfall in mm	10-year Moving average
1951	1603	
1952	1922	
1953	2836	
1954	1638	
1955	2610	2252
1956	2843	2228
1957	1985	2226
1958	2075	2145
1959	3029	2254
1960	1978	2227
1961	1368	2118
1962	1896	2115
1963	2027	2129
1964	2729	2043
1965	2335	2040
1966	1754	2114
1967	1956	2105
1968	2214	2149
1969	2170	2183
1970	1946	2190
1971	2112	2269
1972	1806	2358
1973	2464	2329
1974	3071	2345
1975	2403	2383
1976	2548	2390
1977	2847	2445
1978	1924	2483
1979	2330	2443
1980	2321	2400
1981	2187	2466
1982	2354	2413
1983	2840	2541
1984	2679	2538
1985	1970	2550
1986	3203	2662
1987	2317	2623
1988	3209	2666
1989	2300	2608
1990	2439	2674
1991	3311	
1992	1966	
1993	3262	
1994	2105	
1995	2625	
Mean	2344.6	2336
Stdev	479.9857195	191.123

Table D.7 : Summer Rainfall for Mymensingh (1951-1995)

Year	Summer Rainfall in mm	10-year Moving average
1951	177	
1952	336	
1953	625	
1954	401	
1955	198	368
1956	642	381
1957	74	392
1958	365	366
1959	575	376
1960	283	385
1961	310	348
1962	442	382
1963	367	382
1964	500	373
1965	288	375
1966	273	363
1967	415	340
1968	369	344
1969	484	341
1970	299	355
1971	193	361
1972	216	425
1973	398	445
1974	477	423
1975	424	476
1976	337	527
1977	1056	551
1978	570	581
1979	264	585
1980	823	588
1981	700	614
1982	465	554
1983	693	592
1984	519	596
1985	452	571
1986	596	581
1987	462	552
1988	943	541
1989	308	545
1990	573	538
1991	800	
1992	176	
1993	576	
1994	560	
1995	386	
	453	459
	206.7057881	98.4215

Table D.8 : Monsoon Rainfall for Mymensingh (1951-1995)

Year	Monsoon Rainfall in mm	10-year Moving average
1951	989	
1952	1276	
1953	2009	
1954	1006	
1955	2195	1592
1956	2028	1590
1957	1547	1596
1958	1420	1536
1959	1810	1613
1960	1636	1586
1961	969	1509
1962	1335	1489
1963	1415	1517
1964	1771	1499
1965	1933	1470
1966	1255	1549
1967	1347	1553
1968	1694	1602
1969	1634	1643
1970	1342	1621
1971	1765	1696
1972	1377	1703
1973	1899	1665
1974	2183	1700
1975	1715	1693
1976	2007	1649
1977	1409	1696
1978	1321	1674
1979	1977	1648
1980	1276	1613
1981	1326	1604
1982	1851	1631
1983	1671	1688
1984	1926	1658
1985	1363	1687
1986	1920	1744
1987	1678	1709
1988	1893	1780
1989	1679	1715
1990	1562	1778
1991	1897	
1992	1505	
1993	2375	
1994	1278	
1995	1994	
	1632	1630
	336.500196	80.1863

Table D.9 : One day annual maximum Rainfall for Mymensingh (1951-1995)

Year	ne day annual maximum Rainfall (mm)	10-year Moving average
1951	99	
1952	95	
1953	119	
1954	95	
1955	192	155
1956	245	156
1957	178	159
1958	145	164
1959	249	174
1960	133	167
1961	105	152
1962	132	145
1963	166	149
1964	198	138
1965	114	135
1966	100	134
1967	103	132
1968	194	134
1969	134	125
1970	102	129
1971	95	135
1972	117	142
1973	180	140
1974	106	147
1975	156	148
1976	164	154
1977	167	156
1978	175	157
1979	204	158
1980	120	156
1981	146	160
1982	144	156
1983	192	165
1984	109	161
1985	143	161
1986	202	174
1987	127	171
1988	261	170
1989	165	174
1990	125	172
1991	268	
1992	116	
1993	181	
1994	151	
1995	119	
Mean	151.8	153
Stdev	46.57086487	14.056404

Table D.10 : Number of Rainy days for Mymensingh (1951-1995)

Year	Number of Rainy Days		
	Summer	Monsoon	Annual Total
1951	19	51	87
1952	29	80	121
1953	29	75	115
1954	18	54	87
1955	26	73	111
1956	32	67	113
1957	9	61	83
1958	26	80	115
1959	27	74	122
1960	21	79	106
1961	15	67	90
1962	23	73	109
1963	26	78	117
1964	26	81	123
1965	18	81	110
1966	8	63	85
1967	20	67	95
1968	22	78	108
1969	20	80	105
1970	15	74	101
1971	20	92	126
1972	20	55	81
1973	26	75	117
1974	29	69	110
1975	26	70	108
1976	24	82	117
1977	34	82	136
1978	33	71	106
1979	18	76	107
1980	34	90	133
1981	34	73	117
1982	23	82	113
1983	28	78	119
1984	24	94	128
1985	28	75	114
1986	28	81	125
1987	23	81	116
1988	41	89	148
1989	20	79	113
1990	42	82	142
1991	38	91	147
1992	17	74	107
1993	31	86	136
1994	22	88	127
1995	18	94	134
Mean	24.6666667	76.555556	114
Stdev	7.38548946	9.9830665	16.2032544

Table D.11 : Annual Rainfall for Tangail (1962-1995)

Year	Annual Rainfall in mm	10-year Moving average
1962	650	
1963	1348	
1964	1612	
1965	1818	
1966	1330	1459
1967	1452	1506
1968	1604	1577
1969	1466	1600
1970	1749	1507
1971	1565	1511
1972	1117	1553
1973	2055	1567
1974	1846	1552
1975	883	1530
1976	1377	1537
1977	1868	1580
1978	1744	1603
1979	1319	1654
1980	1523	1730
1981	1640	1843
1982	1545	1829
1983	2285	1868
1984	2352	1886
1985	1644	1915
1986	2508	2059
1987	1730	2087
1988	2133	2116
1989	1501	2121
1990	1814	2262
1991	3079	
1992	1821	
1993	2582	
1994	2398	
1995	3049	
Mean	1777	1738
Stdev	536.2342628	241

Table D.13 : Summer Rainfall for Tangail (1962-1995)

Year	Summer Rainfall in mm	10-year Moving average
1962	261	
1963	354	
1964	407	
1965	220	
1966	115	270
1967	366	269
1968	344	285
1969	299	293
1970	218	281
1971	120	294
1972	242	297
1973	518	322
1974	488	295
1975	99	301
1976	249	342
1977	393	357
1978	598	355
1979	22	338
1980	279	364
1981	529	373
1982	400	365
1983	493	353
1984	318	392
1985	355	411
1986	346	415
1987	307	394
1988	477	404
1989	418	437
1990	464	433
1991	570	
1992	190	
1993	595	
1994	653	
1995	314	
	354	346
	153.9944688	53

Table D.12 : Monsoon Rainfall for Tangail (1961-1995)

Year	Monsoon Rainfall in mm	10-year Moving average
1961	509	
1962	331	
1963	994	
1964	937	
1965	1566	954
1966	972	1033
1967	946	1082
1968	1141	1121
1969	1067	1151
1970	1080	1067
1971	1294	1080
1972	825	1101
1973	1379	1100
1974	1236	1103
1975	729	1102
1976	1102	1075
1977	1160	1101
1978	1125	1109
1979	1101	1177
1980	1068	1211
1981	1023	1260
1982	1087	1276
1983	1455	1294
1984	1917	1266
1985	1071	1278
1986	1590	1383
1987	1320	1425
1988	1308	1454
1989	821	1405
1990	1193	1540
1991	2071	
1992	1507	
1993	1739	
1994	1431	
1995	2421	
	1215	1198
	410.144504	148

Table D.14 : One day annual maximum Rainfall for Tangail (1961-1995)

Year	ne day annual maximum Rainfall (mm)	10-year Moving average
1961	50	
1962	35	
1963	146	
1964	101	
1965	135	89
1966	75	100
1967	91	104
1968	90	98
1969	82	98
1970	85	95
1971	160	105
1972	70	107
1973	86	111
1974	106	116
1975	106	121
1976	177	114
1977	106	119
1978	128	122
1979	140	137
1980	134	137
1981	86	140
1982	121	138
1983	117	146
1984	250	147
1985	109	144
1986	207	148
1987	83	154
1988	210	164
1989	150	148
1990	104	146
1991	130	
1992	180	
1993	215	
1994	89	
1995	92	
Mean	121.3142857	125
Stdev	48.61782016	21.610757

Table D.15 : Number of Rainy days for Tangail (1962-1995)

Year	Number of Rainy Days		
	Summer	Monsoon	Annual Total
1961	-	51	-
1962	24	50	84
1963	29	66	95
1964	25	75	120
1965	10	85	101
1966	10	71	100
1967	23	68	101
1968	23	73	104
1969	17	66	92
1970	12	82	113
1971	15	79	99
1972	8	48	60
1973	41	91	146
1974	28	71	113
1975	12	39	57
1976	23	83	110
1977	34	67	112
1978	30	73	109
1979	9	60	71
1980	15	65	83
1981	22	70	95
1982	28	69	101
1983	23	61	101
1984	22	82	113
1985	22	82	113
1986	23	77	117
1987	20	71	100
1988	35	71	121
1989	21	66	99
1990	30	70	113
1991	34	88	136
1992	15	74	99
1993	28	73	117
1994	23	88	127
1995	22	96	138
Mean	22.2352941	71.457143	104.705882
Stdev	8.07186969	12.358238	19.3790412

Table D.16 : Annual average maximum temperature for Dhaka City (1953-1995)

Year	Annual av. maximum temperature (celcious)	10-year Moving average
1953	30.8	
1954	30.3	
1955	30.2	
1956	29.9	
1957	30.5	30.3
1958	30.9	30.3
1959	29.8	30.2
1960	30.6	30.2
1961	29.7	30.3
1962	30.4	30.2
1963	30.4	30.2
1964	30.1	30.2
1965	30.1	30.2
1966	30.4	30.2
1967	30.1	30.2
1968	30.2	30.1
1969	30.4	30.1
1970	30.2	30.1
1971	29.6	30.1
1972	30.5	30.1
1973	30.0	30.1
1974	30.1	30.1
1975	30.1	30.1
1976	30.2	30.2
1977	29.8	30.2
1978	30.2	30.2
1979	30.8	30.2
1980	30.3	30.3
1981	30.1	30.5
1982	30.4	30.6
1983	30.2	30.8
1984	30.5	30.8
1985	31.1	30.8
1986	31.4	30.8
1987	31.6	30.9
1988	31.6	30.9
1989	31.4	30.9
1990	30.1	31.0
1991	30.2	
1992	30.7	
1993	30.3	
1994	31.0	
1995	31.4	
Mean	30.4	30.4
Stdev	0.504583321	0.2952

Table D.17 : Annual average minimum temperature for Dhaka City (1953-1995)

Year	Annual av. minimum temperature (celcious)	10-year Moving average
1953	20.9	
1954	20.7	
1955	20.6	
1956	20.9	
1957	20.8	20.9
1958	21.6	20.9
1959	20.9	20.9
1960	21.0	21.0
1961	20.9	21.0
1962	20.5	21.0
1963	20.9	21.0
1964	21.4	21.0
1965	20.9	21.1
1966	21.2	21.1
1967	20.9	21.2
1968	21.1	21.2
1969	21.3	21.2
1970	21.5	21.2
1971	21.4	21.2
1972	21.0	21.2
1973	21.4	21.2
1974	21.2	21.3
1975	21.1	21.3
1976	21.3	21.2
1977	21.2	21.3
1978	20.8	21.3
1979	21.8	21.3
1980	21.4	21.4
1981	21.2	21.5
1982	21.2	21.6
1983	21.5	21.7
1984	21.7	21.7
1985	22.1	21.8
1986	21.7	21.9
1987	22.1	21.9
1988	22.2	21.9
1989	21.7	21.8
1990	22.2	21.8
1991	22.0	
1992	21.7	
1993	21.3	
1994	21.4	
1995	21.8	
	21.3	21.3
	0.5	0.31767

Table D.18 : Annual mean temperature for Dhaka City (1953-1995)

Year	Annual mean temperature (celcious)	10-year Moving average
1953	25.8	
1954	25.5	
1955	25.4	
1956	25.4	
1957	25.6	25.6
1958	26.3	25.6
1959	25.4	25.6
1960	25.8	25.6
1961	25.3	25.6
1962	25.4	25.6
1963	25.6	25.6
1964	25.8	25.6
1965	25.5	25.6
1966	25.8	25.6
1967	25.5	25.7
1968	25.6	25.7
1969	25.9	25.7
1970	25.9	25.7
1971	25.5	25.7
1972	25.7	25.7
1973	25.7	25.7
1974	25.6	25.7
1975	25.6	25.7
1976	25.7	25.7
1977	25.5	25.7
1978	25.5	25.7
1979	26.3	25.8
1980	25.9	25.9
1981	25.7	26.0
1982	25.8	26.1
1983	25.8	26.2
1984	26.1	26.3
1985	26.6	26.3
1986	26.6	26.3
1987	26.8	26.4
1988	26.9	26.4
1989	26.6	26.4
1990	26.2	26.4
1991	26.1	
1992	26.2	
1993	25.8	
1994	26.2	
1995	26.6	
	25.9	25.8
	0.4	0.29671

Table D.19 : One day annual maximum temperature for Dhaka City (1953-1995)

Year	One day annual maximum temperature (celcious)	10-year Moving average
1953	37.7	
1954	37.3	
1955	36.6	
1956	37.7	
1957	37.7	37.4
1958	37.3	37.4
1959	37.7	37.3
1960	37.7	37.4
1961	37.2	37.4
1962	37.4	37.4
1963	37.2	37.4
1964	36.7	37.4
1965	37.3	37.3
1966	37.6	37.1
1967	37.7	37.1
1968	37.7	37.1
1969	37.2	37.2
1970	37.2	37.2
1971	35.3	37.2
1972	36.8	37.0
1973	37.7	37.0
1974	37.3	37.0
1975	37.6	37.0
1976	37.6	37.1
1977	35.6	37.2
1978	37.2	37.3
1979	37.4	37.3
1980	37.2	37.3
1981	36.5	37.5
1982	38.3	38.1
1983	37.8	38.2
1984	38	38.4
1985	37.8	38.3
1986	39.5	38.4
1987	40.8	38.5
1988	39	38.4
1989	39.4	38.4
1990	35.4	38.5
1991	37.8	
1992	39.2	
1993	37	
1994	37.6	
1995	39	
Mean	37.6	37.5
Stdev	1.0	0.51526

Table D.20 : One day annual minimum temperature for Dhaka City (1953-1995)

Year	One day annual minimum temperature (celcious)	10-year Moving average
1953	6.8	
1954	6.5	
1955	6.4	
1956	7.7	
1957	9	7.2
1958	8.9	7.3
1959	6.8	7.2
1960	7.2	7.3
1961	6.7	7.2
1962	6.1	7.2
1963	7.6	7.0
1964	5.6	7.0
1965	7.2	7.1
1966	7.2	7.3
1967	8.6	7.5
1968	6.7	7.6
1969	7.2	7.8
1970	8.3	7.9
1971	8.9	8.0
1972	7.3	8.0
1973	8.9	7.9
1974	7.2	8.2
1975	8.9	8.2
1976	8.4	8.3
1977	7.8	8.5
1978	6.4	8.3
1979	9.4	8.6
1980	8.6	8.9
1981	10	9.1
1982	8.9	9.2
1983	7.8	9.5
1984	9.6	9.2
1985	11.6	9.4
1986	10.6	9.4
1987	8.8	9.5
1988	9.6	9.5
1989	6.8	9.4
1990	10.7	8.9
1991	10	
1992	9.7	
1993	7.2	
1994	9	
1995	6.5	
	8.1	8.2
	1.4	0.87399

Table D.21 : Summer average maximum temperature for Dhaka City (1953-1995)

Year	Summer av. maximum temperature (celcious)	10-year Moving average
1953	33.5	
1954	34.1	
1955	33.2	
1956	32.6	
1957	33.6	33.4
1958	33.6	33.3
1959	33.1	33.2
1960	33.5	33.2
1961	32.9	33.4
1962	33.6	33.2
1963	32.8	33.2
1964	33.1	33.2
1965	33.1	33.2
1966	34.4	33.2
1967	31.8	33.1
1968	33.4	33.1
1969	33.4	33.0
1970	33.6	33.1
1971	32.6	32.9
1972	33.3	32.9
1973	32.1	32.8
1974	32.9	32.8
1975	33.6	32.8
1976	32.3	32.6
1977	31.8	32.6
1978	32.1	32.6
1979	34.2	32.7
1980	33.0	32.7
1981	31.3	32.8
1982	32.8	33.1
1983	32.3	33.2
1984	33.5	33.3
1985	33.4	33.2
1986	34.2	33.4
1987	34.0	33.5
1988	33.7	33.5
1989	34.8	33.5
1990	32.5	33.6
1991	32.8	
1992	34.1	
1993	32.0	
1994	33.1	
1995	35.0	
	33.2	33.1
	0.81041273	0.28153

Table D.22 : Summer average minimum temperature for Dhaka City (1953-1995)

Year	Summer av. minimum temperature (celcious)	10-year Moving average
1953	23.2	
1954	22.7	
1955	22.1	
1956	22.8	
1957	22.0	22.7
1958	23.1	22.5
1959	22.7	22.6
1960	22.7	22.6
1961	23.8	22.6
1962	21.9	22.7
1963	21.6	22.6
1964	23.2	22.6
1965	22.3	22.7
1966	23.0	22.6
1967	22.2	22.7
1968	22.3	22.7
1969	23.2	22.7
1970	23.5	22.7
1971	22.3	22.7
1972	22.8	22.8
1973	22.5	22.7
1974	22.6	22.7
1975	22.8	22.6
1976	23.1	22.6
1977	22.5	22.5
1978	21.4	22.5
1979	23.3	22.6
1980	22.9	22.7
1981	21.8	22.6
1982	22.3	22.7
1983	22.6	22.9
1984	23.4	23.0
1985	23.9	22.9
1986	22.5	23.1
1987	23.1	23.2
1988	23.4	23.1
1989	23.8	23.1
1990	22.6	23.1
1991	23.2	
1992	23.8	
1993	21.7	
1994	23.1	
1995	23.5	
Mean	22.8	22.7
Stdev	0.623066726	0.19002

Table D.23 : Winter average maximum temperature for Dhaka City (1954-1994)

Year	Winter av. maximum temperature (celcious)	10-year Moving average
1954	27.5	
1955	26.3	
1956	26.3	
1957	25.8	
1958	27.3	26.7
1959	26.5	26.5
1960	27.6	26.5
1961	25.8	26.6
1962	26.2	26.6
1963	27.2	26.5
1964	26.3	26.5
1965	26.3	26.4
1966	26.4	26.5
1967	26.5	26.4
1968	26.3	26.5
1969	26.6	26.4
1970	26.5	26.4
1971	26.0	26.4
1972	25.9	26.4
1973	27.6	26.3
1974	26.0	26.4
1975	26.4	26.3
1976	26.3	26.4
1977	26.2	26.4
1978	25.8	26.2
1979	27.1	26.2
1980	26.0	26.3
1981	26.3	26.5
1982	26.4	26.7
1983	25.6	26.9
1984	26.2	27.0
1985	27.4	27.0
1986	28.0	27.0
1987	28.1	26.9
1988	28.3	27.0
1989	27.3	27.0
1990	26.6	
1991	26.6	
1992	24.8	
1993	26.5	
1994	26.7	
	26.6	26.6
	0.729308058	0.24857

Table D.24 : Winter average minimum temperature for Dhaka City (1954-1994)

Year	Winter av. minimum temperature (celcious)	10-year Moving average
1954	13.2	
1955	12.0	
1956	11.6	
1957	13.1	
1958	13.4	12.6
1959	13.2	12.6
1960	12.6	12.8
1961	13.1	12.9
1962	11.3	13.0
1963	12.7	13.0
1964	13.2	13.0
1965	13.3	13.1
1966	13.3	13.1
1967	14.1	13.5
1968	13.0	13.6
1969	13.3	13.7
1970	13.8	13.7
1971	13.4	13.8
1972	14.9	13.7
1973	14.1	13.6
1974	13.6	13.6
1975	14.0	13.6
1976	13.6	13.7
1977	12.9	13.6
1978	12.7	13.6
1979	13.1	13.6
1980	13.9	13.7
1981	14.6	13.9
1982	13.6	14.1
1983	13.6	14.3
1984	14.1	14.4
1985	15.1	14.6
1986	15.2	14.7
1987	14.9	14.8
1988	15.1	14.8
1989	14.3	14.8
1990	15.0	
1991	15.8	
1992	14.9	
1993	13.7	
1994	13.7	
	13.7	13.7
	0.97817068	0.63339

Table D.25 : Annual average maximum temperature for Mymensingh (1951-1995)

Year	Annual av. maximum temperature (celcious)	10-year Moving average
1951	30.3	
1952	30.1	
1953	30.4	
1954	30.3	
1955	29.9	30.1
1956	29.7	30.1
1957	30.1	30.1
1958	30.3	30.1
1959	29.7	30.0
1960	30.5	30.0
1961	30.4	30.1
1962	30.2	30.0
1963	29.9	30.0
1964	29.8	30.0
1965	29.6	29.9
1966	30.2	29.9
1967	29.8	29.8
1968	29.6	29.8
1969	29.8	29.9
1970	29.8	30.0
1971	30.5	30.0
1972	29.3	30.0
1973	30.1	30.0
1974	30.6	30.1
1975	30.2	30.1
1976	30.1	30.1
1977	30.0	30.1
1978	29.8	30.1
1979	30.9	30.0
1980	30.1	30.0
1981	29.9	30.0
1982	30.0	30.0
1983	29.6	30.0
1984	29.6	29.9
1985	30.0	29.9
1986	30.0	29.9
1987	30.3	29.9
1988	30.0	29.9
1989	29.9	29.9
1990	29.7	29.9
1991	29.7	
1992	30.4	
1993	29.4	
1994	30.0	
1995	30.0	
Mean	30.0	30
Stdev	0.3	0.09142

Table D.26 : Annual average minimum temperature for Mymensingh (1951-1995)

Year	Annual av. minimum temperature (celcious)	10-year Moving average
1951	20.4	
1952	20.4	
1953	21.0	
1954	20.5	
1955	20.7	20.7
1956	20.7	20.7
1957	20.7	20.7
1958	21.2	20.7
1959	20.6	20.7
1960	20.8	20.7
1961	20.8	20.7
1962	20.3	20.7
1963	20.5	20.7
1964	20.9	20.7
1965	20.8	20.7
1966	20.7	20.7
1967	20.5	20.7
1968	20.7	20.7
1969	20.8	20.7
1970	20.8	20.7
1971	20.9	20.7
1972	20.3	20.7
1973	20.7	20.6
1974	20.6	20.6
1975	20.9	20.6
1976	20.4	20.6
1977	20.5	20.6
1978	20.3	20.6
1979	21.0	20.6
1980	20.5	20.6
1981	20.4	20.6
1982	20.4	20.7
1983	20.8	20.8
1984	20.5	20.8
1985	21.0	20.8
1986	20.9	20.7
1987	21.4	20.7
1988	21.4	20.7
1989	20.6	20.7
1990	20.2	20.7
1991	19.6	
1992	20.7	
1993	20.7	
1994	20.7	
1995	21.0	
	20.7	20.7
	0.3	0.06537

Table D.27 : Annual mean temperature for Mymensingh (1951-1995)

Year	Annual mean temperature (celcious)	10-year Moving average
1951	25.3	
1952	25.2	
1953	25.7	
1954	25.4	
1955	25.3	25.4
1956	25.2	25.4
1957	25.4	25.4
1958	25.7	25.4
1959	25.2	25.4
1960	25.6	25.4
1961	25.6	25.4
1962	25.3	25.4
1963	25.2	25.3
1964	25.3	25.3
1965	25.2	25.3
1966	25.4	25.3
1967	25.1	25.3
1968	25.1	25.3
1969	25.3	25.3
1970	25.3	25.3
1971	25.7	25.3
1972	24.8	25.3
1973	25.4	25.3
1974	25.6	25.4
1975	25.6	25.4
1976	25.3	25.3
1977	25.2	25.4
1978	25.1	25.3
1979	25.9	25.3
1980	25.3	25.3
1981	25.1	25.3
1982	25.2	25.4
1983	25.2	25.4
1984	25.1	25.4
1985	25.5	25.3
1986	25.4	25.3
1987	25.9	25.3
1988	25.7	25.3
1989	25.3	25.3
1990	25.0	25.3
1991	24.7	
1992	25.6	
1993	25.1	
1994	25.3	
1995	25.5	
	25.3	25.3
	0.25715337	0.04649

Table D.28 : One day annual maximum temperature for Mymensingh (1951-1995)

Year	One day annual maximum temperature (celcious)	10-year Moving average
1951	37.7	
1952	37.7	
1953	37.7	
1954	37.7	
1955	36.6	37.6
1956	37.4	37.5
1957	37.7	37.5
1958	37.7	37.5
1959	37.7	37.3
1960	37.7	37.4
1961	37.1	37.4
1962	37.7	37.4
1963	37.7	37.3
1964	36.1	37.2
1965	37.4	37.1
1966	37.3	37.2
1967	37.2	37.2
1968	37.2	37.1
1969	36.1	37.2
1970	37.2	37.2
1971	38.2	37.2
1972	37.2	37.3
1973	37.2	37.3
1974	37.2	37.4
1975	37.6	37.4
1976	37.2	37.4
1977	37.4	37.4
1978	37.5	37.4
1979	37.7	37.4
1980	36.9	37.2
1981	38.5	37.1
1982	37.1	37.1
1983	36.7	36.9
1984	37.6	36.9
1985	35.4	36.8
1986	36.4	36.6
1987	37.5	36.7
1988	35.6	36.8
1989	37.4	36.7
1990	35.7	36.9
1991	37	
1992	38.1	
1993	37	
1994	37	
1995	37.6	
Mean	37.2	37
Stdev	0.65700	0.25245

Table D.29 : One day annual minimum temperature for Mymensingh (1951-1995)

Year	One day annual minimum temperature (celcious)	10-year Moving average
1951	6.2	
1952	8.9	
1953	8.9	
1954	7.8	
1955	7.8	8.7
1956	9.5	8.7
1957	10.1	8.6
1958	10.1	8.5
1959	9.5	8.3
1960	8.6	8.4
1961	5.6	8.5
1962	8.1	8.4
1963	7.8	8.2
1964	5.6	8.2
1965	9.4	8.2
1966	10	8.5
1967	9.4	8.2
1968	7.8	8.4
1969	9.4	8.8
1970	8.9	8.7
1971	8.4	8.6
1972	5.6	8.5
1973	9.7	8.2
1974	9.4	8.2
1975	8.3	8.2
1976	9.4	8.2
1977	8.4	8.5
1978	4.2	8.4
1979	10	8.3
1980	8.7	8.4
1981	8.3	8.5
1982	8.4	8.5
1983	8.4	8.9
1984	9	8.7
1985	9.6	8.6
1986	9.8	8.3
1987	8.3	8.4
1988	8.6	8.4
1989	7.7	8.3
1990	7.4	7.9
1991	5.8	
1992	9.5	
1993	8	
1994	8.5	
1995	5.8	
	8.3	8.4
	1.41729	0.20805

Table D.30 : Summer average maximum temperature for Mymensingh (1951-1995)

Year	Summer av. maximum temperature (celcious)	10-year Moving average
1951	33.2	
1952	31.8	
1953	32.9	
1954	33.7	
1955	32.8	32.7
1956	31.9	32.7
1957	33.4	32.8
1958	33.0	32.7
1959	32.2	32.6
1960	32.6	32.5
1961	33.2	32.7
1962	32.9	32.5
1963	31.6	32.4
1964	32.1	32.4
1965	31.9	32.4
1966	33.9	32.4
1967	31.6	32.1
1968	32.0	32.2
1969	32.3	32.1
1970	33.0	32.2
1971	32.4	32.1
1972	30.7	32.2
1973	31.8	32.1
1974	31.5	32.3
1975	33.1	32.1
1976	33.1	31.9
1977	32.1	32.0
1978	31.0	32.0
1979	34.0	32.0
1980	31.9	31.9
1981	30.2	31.7
1982	31.7	31.7
1983	31.0	31.7
1984	31.7	31.6
1985	32.0	31.4
1986	31.8	31.5
1987	32.0	31.6
1988	30.9	31.6
1989	32.7	31.5
1990	30.1	31.6
1991	31.1	
1992	32.9	
1993	30.3	
1994	31.6	
1995	32.5	
	32.1	32.1
	0.95154634	0.40357

Table D.31 : Summer average minimum temperature for Mymensingh (1951-1995)

Year	Summer av. minimum temperature (celcious)	10-year Moving average
1951	20.2	
1952	19.5	
1953	21.7	
1954	21.7	
1955	21.7	21.4
1956	22.2	21.6
1957	21.8	21.8
1958	21.9	21.7
1959	21.6	21.7
1960	21.7	21.6
1961	22.7	21.5
1962	20.7	21.4
1963	20.7	21.3
1964	21.6	21.4
1965	21.3	21.4
1966	21.2	21.3
1967	20.7	21.4
1968	21.2	21.5
1969	22.1	21.4
1970	22.1	21.4
1971	21.4	21.4
1972	21.7	21.5
1973	21.6	21.4
1974	21.0	21.3
1975	21.4	21.3
1976	21.3	21.2
1977	21.2	21.2
1978	20.1	21.1
1979	21.6	21.2
1980	21.3	21.3
1981	21.1	21.3
1982	21.1	21.3
1983	21.4	21.6
1984	21.5	21.6
1985	22.1	21.5
1986	21.2	21.5
1987	22.0	21.5
1988	22.2	21.5
1989	22.1	21.5
1990	20.5	21.5
1991	20.5	
1992	21.9	
1993	20.6	
1994	21.8	
1995	21.9	
Mean	21.4	21.4
Stdev	0.642149969	0.14796

Table D.32 : Winter average maximum temperature for Mymensingh (1952-1994)

Year	Winter av. maximum temperature (celcious)	10-year Moving average
1952	27.3	
1953	26.1	
1954	27.2	
1955	26.3	
1956	25.7	26.4
1957	25.0	26.2
1958	26.4	26.3
1959	25.9	26.2
1960	27.8	26.2
1961	26.2	26.3
1962	25.8	26.4
1963	27.0	26.3
1964	26.3	26.3
1965	26.0	26.1
1966	26.3	26.1
1967	26.6	26.1
1968	25.5	26.0
1969	26.0	26.0
1970	25.8	25.9
1971	26.2	26.0
1972	24.8	25.9
1973	26.4	25.9
1974	26.8	26.0
1975	24.9	26.1
1976	26.9	26.1
1977	26.0	26.2
1978	25.6	26.1
1979	27.1	26.0
1980	26.0	26.1
1981	26.2	26.0
1982	26.4	26.1
1983	25.5	26.3
1984	25.4	26.2
1985	25.7	26.2
1986	26.5	26.2
1987	27.1	26.1
1988	27.0	26.1
1989	25.9	26.1
1990	26.0	
1991	26.8	
1992	24.9	
1993	25.5	
1994	26.0	
	26.2	26.1
	0.679782494	0.1308

Table D.33 : Winter average minimum temperature for Mymensingh (1952-1994)

Year	Winter av. minimum temperature (celcious)	10-year Moving average
1952	11.7	
1953	13.0	
1954	13.4	
1955	13.0	
1956	12.6	13.2
1957	13.8	13.3
1958	13.8	13.3
1959	13.5	13.3
1960	13.5	13.3
1961	13.5	13.4
1962	12.6	13.4
1963	13.3	13.4
1964	13.0	13.3
1965	13.8	13.3
1966	13.4	13.3
1967	14.1	13.3
1968	13.2	13.3
1969	13.0	13.3
1970	13.4	13.3
1971	13.2	13.2
1972	12.7	13.1
1973	13.3	13.1
1974	13.1	13.1
1975	13.3	13.0
1976	13.1	13.0
1977	13.2	13.0
1978	12.7	13.0
1979	12.6	12.9
1980	13.2	13.0
1981	12.8	13.0
1982	12.8	13.1
1983	13.3	13.3
1984	12.5	13.4
1985	13.5	13.3
1986	13.7	13.3
1987	14.4	13.3
1988	14.1	13.3
1989	13.4	13.4
1990	12.9	
1991	12.0	
1992	13.5	
1993	13.3	
1994	13.3	
	13.2	13.2
	0.52233827	0.14833

Table D.34 : Annual average Atmospheric pressure for Dhaka city (1953-1994)

Year	Annual av. Atmospheric pressure (mb)	10-year Moving average
1953	1007.7	
1954	1006.9	
1955	1007.2	
1956	1007.1	
1957	1007.9	1007.3
1958	1007.7	1007.3
1959	1007.2	1007.3
1960	1007.1	1007.4
1961	1006.8	1007.4
1962	1007.1	1007.3
1963	1007.9	1007.3
1964	1007.2	1007.4
1965	1007.7	1007.4
1966	1007.2	1007.5
1967	1007.5	1007.6
1968	1007.8	1007.6
1969	1007.6	1007.6
1970	1007.5	1007.5
1971	1007.8	1007.6
1972	1007.9	1007.7
1973	1007.5	1007.7
1974	1007.4	1007.7
1975	1007.3	1007.8
1976	1007.6	1007.8
1977	1008.2	1007.8
1978	1008.1	1007.9
1979	1008.1	1007.9
1980	1007.8	1007.9
1981	1008.1	1007.9
1982	1008.1	1008.0
1983	1008.5	1007.9
1984	1007.2	1007.9
1985	1007.0	1007.9
1986	1008.2	1007.9
1987	1008.6	1008.0
1988	1007.6	1008.0
1989	1007.8	1008.0
1990	1008.1	
1991	1008.3	
1992	1008.6	
1993	1008.4	
1994	1007.9	
Mean	1007.7	1007.7
Stdev	0.478508507	0.25135

Table D.35 : Annual average Atmospheric pressure for Mymensingh (1951-1995)

Year	Annual av. Atmospheric pressure (mb)	10-year Moving average
1951	1008.6	
1952	1008.6	
1953	1008.9	
1954	1008.0	
1955	1008.3	1008.5
1956	1008.1	1008.4
1957	1009.0	1008.4
1958	1009.0	1008.4
1959	1008.4	1008.5
1960	1008.3	1008.5
1961	1008.0	1008.6
1962	1008.6	1008.5
1963	1008.9	1008.5
1964	1008.4	1008.6
1965	1008.9	1008.6
1966	1008.3	1008.6
1967	1008.6	1008.7
1968	1008.7	1008.6
1969	1008.8	1008.6
1970	1008.4	1008.5
1971	1008.8	1008.6
1972	1009.0	1008.6
1973	1008.3	1008.6
1974	1008.2	1008.6
1975	1008.3	1008.6
1976	1008.9	1008.5
1977	1008.8	1008.5
1978	1008.7	1008.5
1979	1008.4	1008.5
1980	1008.3	1008.5
1981	1008.5	1008.5
1982	1008.5	1008.5
1983	1009.0	1008.5
1984	1008.0	1008.5
1985	1008.1	1008.5
1986	1008.7	1008.5
1987	1009.1	1008.5
1988	1008.1	1008.6
1989	1008.3	1008.6
1990	1008.5	1008.6
1991	1008.7	
1992	1009.0	
1993	1009.0	
1994	1008.5	
1995	1008.1	
	1008.5	1008.5
	0.3	0.06268

Table D.36 : Monthly & Annualy Rainfall in mm

Station :Dhaka (BMD)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Std.	C.V.
1953	10	2	90	90	274	333	392	326	352	52	13	0	1934	158.77	0.9851
1954	14	0	0	86	211	810	320	433	251	218	0	10	2353	242.59	1.2372
1955	0	0	0	54	167	254	502	247	149	71	99	0	1543	149.84	1.1653
1956	12	5	189	135	69	433	690	489	286	121	53	13	2495	222.03	1.0679
1957	68	69	16	117	114	487	385	125	144	29	0	0	1554	153.05	1.1819
1958	0	95	5	105	200	161	184	267	91	191	0	0	1299	93.072	0.8598
1959	15	4	78	78	254	270	230	413	445	568	0	0	2355	198.12	1.0095
1960	0	0	16	19	358	304	655	189	231	38	24	0	1834	204.72	1.3395
1961	12	12	20	205	219	856	296	288	221	52	0	0	2181	242.92	1.3366
1962	0	15	6	166	205	191	355	273	395	180	0	0	1786	144.44	0.9705
1963	0	0	51	98	219	621	404	186	200	182	7	3	1971	189.03	1.1509
1964	9	42	18	296	236	354	629	155	269	283	70	0	2361	186.67	0.9487
1965	0	14	22	55	305	442	304	480	300	50	131	1	2104	179.82	1.0256
1966	12	0	7	34	127	270	291	306	496	261	14	15	1833	166.04	1.087
1967	23	12	168	185	216	241	363	504	266	74	1	0	2053	159.16	0.9303
1968	0	5	121	64	194	590	480	212	128	69	74	0	1937	189.21	1.1722
1969	0	1	65	86	95	249	198	540	201	103	2	0	1540	155.75	1.2136
1970	16	8	23	45	192	276	496	280	200	427	32	0	1995	173.73	1.045
1971	3	28	12	176	302	308	471	540	262	118	86	0	2306	185.44	0.965
1972	0	11	12	248	340	353	249	380	150	105	0	0	1848	152.94	0.9931
1973	0	21	32	131	621	414	241	238	348	128	64	86	2324	188.12	0.9714
1974	1	29	15	197	191	247	604	389	235	145	1	0	2054	185.42	1.0833
1975	1	29	13	98	317	235	559	307	329	232	25	0	2145	178.97	1.0012
1976	0	7	117	34	459	627	346	361	165	114	8	0	2238	211.41	1.1336
1977	0	66	71	255	381	252	306	92	131	273	10	24	1861	131.06	0.8451
1978	0	20	18	194	454	529	320	426	192	98	0	0	2251	198.27	1.057
1979	3	13	6	17	114	258	267	525	382	146	55	51	1837	170.19	1.1118
1980	3	32	54	147	414	323	380	269	296	300	0	0	2218	161.16	0.8719
1981	10	42	109	274	272	168	356	188	320	82	9	35	1865	125.66	0.8085
1982	0	15	81	104	154	514	136	346	258	146	51	0	1805	154.54	1.0274
1983	18	61	138	318	348	300	179	437	322	253	0	18	2392	150.62	0.7556
1984	13	1	5	124	707	637	694	311	478	58	0	0	3028	296.55	1.1752
1985	8	1	195	176	300	399	262	317	306	79	0	10	2053	146.52	0.8564
1986	22	0	23	247	191	304	443	171	687	237	172	3	2500	203	0.9744
1987	4	0	33	230	109	316	526	462	363	104	7	33	2187	190.93	1.0476
1988	0	44	74	282	513	580	255	169	196	213	153	3	2482	184.37	0.8914
1989	0	32	0	85	228	319	347	59	305	240	0	12	1627	140.15	1.0337
1990	0	36	151	154	202	229	567	227	247	181	103	6	2103	150.74	0.8601
1991	27	8	46	53	529	320	318	345	692	392	14	106	2850	228.67	0.9628
1992	1	47	0	25	153	132	386	182	148	83	2	0	1159	113.88	1.179
1993	5	53	87	113	556	486	418	439	374	217	19	0	2767	210.03	0.9109
1994	11	39	118	201	254	273	216	247	169	39	47	0	1614	103.52	0.7697
1995	8	31	0	88	261	237	353	353	204	96	112	0	1743	132.28	0.9107
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Mean	7.6512	22.093	53.605	136.95	279.65	369.81	380.77	313.79	283.35	163.91	33.907	9.9767	2055.5		
Std	12.004	22.868	55.88	82.5	146.54	168.39	143.51	126.18	132.02	113.97	46.21	22.344	390.04		
C.V.	1.5689	1.0351	1.0424	0.6024	0.524	0.4553	0.3769	0.4021	0.4659	0.6954	1.3628	2.2396	0.1898		

Table D.37 : Monthly & Annualy Rainfall in mm

Station :Mymensingh (BMD)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Std.	C.V.
1951	0	0	12	25	140	401	275	167	146	360	77	0	1603	143.78	1.0763
1952	0	0	25	96	215	166	371	271	468	254	56	0	1922	157.69	0.9846
1953	20	0	107	229	289	473	407	341	788	179	3	0	2836	240.5	1.0176
1954	24	48	23	60	318	367	301	93	245	142	0	17	1638	134.49	0.9853
1955	6	4	55	46	97	583	536	702	374	130	77	0	2610	257.54	1.1841
1956	6	0	67	104	471	581	433	727	287	148	19	0	2843	256.17	1.0813
1957	145	53	0	1	73	579	352	282	334	166	0	0	1985	185.52	1.1215
1958	0	93	1	75	289	432	271	523	194	197	0	0	2075	178.13	1.0301
1959	18	0	158	45	372	505	194	931	180	626	0	0	3029	299.21	1.1854
1960	0	0	69	27	187	363	339	355	579	53	6	0	1978	196.61	1.1928
1961	0	0	0	15	295	456	242	150	121	86	3	0	1368	148.43	1.302
1962	6	10	1	51	390	461	311	353	210	103	0	0	1896	176.8	1.119
1963	0	0	37	72	258	518	410	313	174	161	82	2	2027	172.69	1.0223
1964	13	49	31	101	368	598	488	237	448	396	0	0	2729	221.15	0.9724
1965	0	19	25	59	204	409	558	669	297	76	19	0	2335	235.93	1.2125
1966	20	0	4	140	129	218	386	472	179	189	10	7	1754	155.94	1.0669
1967	16	0	46	74	295	211	451	402	283	155	23	0	1956	162.43	0.9965
1968	5	2	37	39	293	464	618	244	368	144	0	0	2214	211.75	1.1477
1969	0	2	139	169	176	398	335	634	267	50	0	0	2170	198.36	1.0969
1970	23	0	6	117	176	570	323	207	242	274	8	0	1946	174.63	1.0768
1971	17	0	0	0	193	588	407	397	373	79	58	0	2112	209.67	1.1913
1972	0	20	0	89	127	625	418	130	204	163	30	0	1806	191.64	1.2733
1973	0	15	0	114	284	538	527	121	713	56	38	58	2464	249.74	1.2163
1974	0	0	21	109	347	621	860	282	420	407	4	0	3071	285.03	1.1137
1975	0	0	5	127	292	98	798	530	289	241	23	0	2403	250.39	1.2504
1976	0	10	5	84	248	625	635	490	257	190	4	0	2548	245.65	1.1569
1977	12	119	0	327	729	794	250	176	189	196	36	19	2847	265.76	1.1202
1978	0	0	46	119	405	509	475	124	213	33	0	0	1924	195.02	1.2163
1979	0	8	6	45	213	425	704	436	412	52	18	11	2330	240.14	1.2367
1980	2	11	16	84	723	289	309	464	214	209	0	0	2321	226.64	1.1718
1981	12	48	51	280	369	103	683	262	278	22	0	79	2187	202.44	1.1108
1982	0	2	65	124	276	689	582	337	243	28	8	0	2354	237.59	1.2111
1983	9	3	66	115	512	112	413	865	281	453	0	11	2840	273.58	1.156
1984	13	0	15	28	476	512	689	257	468	221	0	0	2679	252.34	1.1303
1985	9	37	2	190	260	505	251	250	357	104	0	5	1970	165.3	1.0069
1986	0	4	0	400	196	284	673	316	647	583	86	14	3203	259.9	0.9737
1987	0	0	18	82	362	406	410	479	383	159	17	1	2317	196.64	1.0184
1988	0	45	115	94	734	587	586	411	309	195	120	13	3209	254	0.9498
1989	6	17	18	23	267	290	812	171	406	284	0	6	2300	243.06	1.2681
1990	0	83	67	116	390	529	477	237	319	213	7	1	2439	188.76	0.9287
1991	2	15	44	77	679	603	322	237	735	520	0	77	3311	285.34	1.0341
1992	6	36	0	20	156	270	762	155	318	241	1	1	1966	221.72	1.3533
1993	69	13	44	182	350	848	512	490	525	229	0	0	3262	273.89	1.0076
1994	8	59	121	116	289	324	336	333	295	189	35	0	2105	134.38	0.7661
1995	10	19	20	81	285	559	682	523	230	115	101	0	2625	241.56	1.1043
Mean	11.093	19.628	36.07	103.49	321.91	463.23	477.4	374.6	340.65	196.67	19.442	7.4884	2344.6		
Std	23.678	27.931	40.268	81.53	160.74	173.11	173.28	198.63	157.92	142.15	31.564	18.218	479.99		
C.V.	2.1345	1.423	1.1164	0.7878	0.4993	0.3737	0.363	0.5302	0.4636	0.7228	1.6235	2.4329	0.2047		

Table D.38 : Monthly & Annualy Rainfall in mm

Station :Tangail (BWDB)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Std.	C.V.
1962	9	6	0	37	225	101	121	50	59	42	0	0	650.37	67.116	1.2384
1963	0	0	7	51	297	380	266	187	161	0	0	0	1348.2	139.85	1.2447
1964	0	37	9	151	248	244	448	149	95	231	0	0	1611.8	139.62	1.0395
1965	0	4	17	64	140	437	299	512	319	4	19	4	1817.8	188.87	1.2468
1966	31	0	0	25	90	168	234	406	164	189	11	12	1329.8	125.39	1.1316
1967	13	1	163	57	145	165	208	311	263	126	0	0	1451.6	107.55	0.8891
1968	0	0	27	90	227	408	309	277	147	106	13	0	1603.9	140.65	1.0523
1969	3	0	109	90	100	226	184	441	215	77	21	0	1466.1	129.12	1.0568
1970	33	4	8	79	132	257	392	228	204	393	20	0	1748.8	146.95	1.0084
1971	1	0	0	70	120	305	285	278	426	47	34	0	1565.4	151.06	1.158
1972	5	0	6	1	234	298	194	249	85	45	0	0	1117.1	116.11	1.2472
1973	7	58	14	140	364	369	286	249	475	91	3	0	2054.8	170.01	0.9928
1974	0	0	55	268	165	324	514	147	252	122	0	0	1845.7	161.5	1.05
1975	0	0	1	29	69	266	223	134	106	55	0	0	882.94	92.048	1.251
1976	0	0	0	50	199	399	219	369	114	21	5	0	1376.6	148.16	1.2916
1977	13	89	1	164	229	582	275	129	174	158	28	26	1867.8	160.81	1.0332
1978	0	12	26	68	504	411	222	156	336	9	0	0	1744.4	181.37	1.2477
1979	5	2	7	10	4	265	249	387	200	147	8	33	1318.8	134.94	1.2278
1980	6	0	5	88	202	348	286	233	237	109	10	0	1523.3	128.12	1.0093
1981	4	16	12	225	291	133	467	231	193	5	0	63	1640.5	148.36	1.0853
1982	0	3	85	163	152	382	266	335	104	26	29	0	1544.9	134.48	1.0446
1983	5	0	72	144	277	272	470	430	284	304	0	28	2285.2	170.67	0.8962
1984	6	0	15	11	292	798	411	185	523	112	0	0	2352.2	261.14	1.3323
1985	0	0	30	112	212	357	408	95	211	211	0	7	1644.2	143.26	1.0456
1986	6	3	2	150	194	130	437	319	703	497	66	0	2507.9	231.95	1.1099
1987	1	0	33	159	115	285	338	356	341	51	21	31	1730.4	145.34	1.0079
1988	0	44	34	85	358	622	430	171	86	153	149	4	2133.1	193.65	1.0894
1989	0	56	1	87	331	181	317	61	263	199	0	6	1501	127.19	1.0169
1990	0	31	88	205	171	233	500	289	170	123	0	4	1814.1	147.11	0.9731
1991	14	16	80	53	437	366	428	545	732	315	0	93	3079	246.52	0.9608
1992	0	65	0	2	188	392	314	300	501	54	5	0	1821	180.77	1.1912
1993	7	7	44	192	359	527	487	297	428	234	0	0	2582	202.99	0.9434
1994	25	58	86	151	416	359	245	488	339	220	12	0	2398.3	169.94	0.8503
1995	17	67	17	48	249	521	732	707	462	105	125	0	3048.6	276.5	1.0884
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Mean	6.1441	17.058	30.944	97.606	227.53	338.51	337.23	285.21	275.62	134.68	17.006	9.1468	1776.7		
Std	8.8324	25.593	39.175	67.843	111.62	149.64	125.87	146.96	170.92	116.1	33.661	20.285	536.23		
C.V.	1.4375	1.5003	1.266	0.6951	0.4906	0.4421	0.3732	0.5153	0.6201	0.862	1.9794	2.2177	0.3018		

Table D.39 : Monthly & Annualy Average Maximum Temperature in celcius

Station :Dhaka (BMD)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Std.	C.V.
1953	25.2	29.6	32.7	35.1	32.8	31.4	31.1	31.7	32	31	28.7	27.9	30.767	2.6015	0.0846
1954	24.8	29.9	34.7	34.2	33.5	30.2	31	31.1	31.5	29.9	27.8	25.2	30.317	3.1654	0.1044
1955	25.1	28.6	33.1	33.4	33	31.5	30.6	30.7	31.7	31.3	28.4	25.2	30.217	2.8422	0.0941
1956	25.5	28.1	32.2	33.4	32.2	30	30.7	30.9	30.4	31.1	27.6	26.2	29.858	2.4814	0.0831
1957	24.8	26.4	31.3	35.5	34.1	32.1	30.8	31.8	32	31.2	29.5	26.5	30.5	3.1906	0.1046
1958	27.3	28.2	32.4	35	33.4	33	31.4	31	31.9	31.4	29.5	26.6	30.925	2.557	0.0827
1959	25.3	27.5	32.5	33.8	33	31.4	30.5	30.7	30.2	29.2	28	26	29.842	2.7154	0.091
1960	25.6	31.3	30.8	36	33.8	31.9	30.5	31.5	31	30.9	27.5	25.9	30.558	3.0056	0.0984
1961	26	25.4	33.1	33.8	31.8	30.5	31	30.8	30.7	30.4	28	24.6	29.675	2.9982	0.101
1962	25.1	29	33.8	34.4	32.5	31.2	31.7	30.8	31.7	30.4	28.5	25.7	30.4	2.8904	0.0951
1963	25.4	30.5	33.3	33.4	31.8	31.2	31	31.2	31.9	30.3	28.3	26.1	30.367	2.5436	0.0838
1964	24.2	28.7	33.9	32.8	32.6	31.6	30.2	31.2	31.3	30.3	28.1	26.2	30.092	2.843	0.0945
1965	25.3	27.5	32.4	33.7	33.1	30.8	30.6	30.3	31	31.1	29.3	25.5	30.05	2.7205	0.0905
1966	25.5	28.3	32.6	36.1	34.5	31.1	30.8	30.9	30.6	29.8	29	25.1	30.358	3.2177	0.106
1967	25.3	29.2	29.2	33.1	33.2	32.4	31.5	31.1	30.4	30.8	28.4	26.5	30.092	2.4854	0.0826
1968	25	27.4	33	33.7	33.4	30.3	30.7	31.2	32.3	30.6	28.8	25.6	30.167	2.9255	0.097
1969	25.1	29.2	32.3	34	33.9	31.5	31.1	30.2	31.7	30.9	29.2	26.1	30.433	2.7294	0.0897
1970	24.8	28.7	32.4	34.1	34.2	31.9	31	30.9	31.3	29.8	27.9	25.7	30.225	2.9906	0.0989
1971	24.8	27.4	32.6	33.9	31.3	30.3	30.3	29.5	30.7	30.5	27.5	25.7	29.542	2.7111	0.0918
1972	25.9	26	32.7	33.2	33.9	31.9	31.6	30.3	32.3	31.8	29.7	26.4	30.475	2.8712	0.0942
1973	26.6	29.8	30.7	34.3	31.2	31.3	30.9	31.3	31	30.6	27.4	24.5	29.967	2.6036	0.0869
1974	25.3	28.2	31.8	33.7	33.1	31.3	30.9	30.7	31.3	30.6	28.5	25.7	30.092	2.6552	0.0882
1975	25.2	28.2	33.2	34.8	32.7	32	29.8	31.1	30.5	30.7	27.3	25.2	30.058	3.0619	0.1019
1976	25.8	28	31.4	33.5	32.1	30.8	30.8	30.4	31.6	31.3	30.1	26	30.15	2.3682	0.0785
1977	25	27.7	33.2	31.3	30.9	30.3	31.2	31.4	32.2	30.1	28.6	25.7	29.8	2.5467	0.0855
1978	24.4	27.3	31.9	33	31.4	31.1	31.2	31.7	31.3	31.9	30	27.1	30.192	2.5589	0.0848
1979	26.8	27.3	33	34.5	35.1	31.7	31.4	31.6	31.5	31.4	30.3	25.3	30.825	2.9912	0.097
1980	24.7	28	31.8	35.2	31.9	31.6	30.9	31.4	31.4	30.5	29.5	26.7	30.3	2.7565	0.091
1981	25.2	27	30.6	31.3	31.9	32.8	30.6	32.4	31.8	32.4	30	25.6	30.133	2.6935	0.0894
1982	26.3	27.3	30.9	32.8	34.6	31.6	32	31	32.1	32.1	28.1	25.7	30.375	2.8217	0.0929
1983	24.5	26.7	31.5	33	32.3	33	32	31.1	31.2	30.7	30.3	25.9	30.183	2.8654	0.0949
1984	24.9	27.7	34.6	34.5	31.4	30.9	31	31.3	31.4	31.9	29.9	26.8	30.525	2.8712	0.0941
1985	26.3	29.2	34	33.7	32.4	31.7	30.8	31.8	31.9	32.6	30.3	28.1	31.067	2.2757	0.0733
1986	26.5	29.5	35.1	33.5	33.9	33.5	32	33.1	31.3	31.4	29.5	27.2	31.375	2.7116	0.0864
1987	26.7	30.4	33.2	33.8	34.9	34	31.4	31.9	32.3	32.4	30.3	27.4	31.558	2.5239	0.08
1988	27.2	30.2	32.6	35.3	33.2	32	32.3	31.9	33.1	32.8	30.6	27.5	31.558	2.3508	0.0745
1989	25.4	28.9	33.8	36.1	34.4	32.9	32.1	33	32.1	31.6	30.3	26.7	31.442	3.1364	0.0998
1990	25.5	27.5	32.8	32	32.7	32.3	31.1	32.2	32.1	30.2	29.8	26.6	30.4	2.5424	0.0836
1991	24.3	28.9	32.6	34	31.8	31.6	32.1	31.9	30.7	31	28.3	24.8	30.167	3.0356	0.1006
1992	24	25.6	32.6	36.2	33.5	33.7	31.6	32	32.3	31.8	29.5	26.1	30.742	3.6983	0.1203
1993	24.6	28.8	31.3	33.1	31.6	31.8	31.4	31	31.6	31.5	29.5	27.2	30.283	2.3855	0.0788
1994	26.2	26.6	32.4	33.3	33.7	32	32	32	32.9	32.8	29.9	27.7	30.958	2.6777	0.0865
1995	25.4	28	33.8	36.5	34.6	32.9	31.8	32.5	32.5	32.9	29.8	26.4	31.425	3.3602	0.1069
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Mean	25.414	28.226	32.553	34	32.96	31.698	31.149	31.314	31.551	31.114	29.012	26.153	30.429		
Std	0.7903	1.3202	1.1803	1.2073	1.1095	0.9508	0.5759	0.7302	0.684	0.8884	0.9747	0.8656	0.503		
C.V.	0.0311	0.0468	0.0363	0.0355	0.0337	0.03	0.0185	0.0233	0.0217	0.0286	0.0336	0.0331	0.0165		

Table D.40 : Monthly & Annualy Average Minimum Temperature in Celcius

Station :Dhaka (BMD)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Std.	C.V.
1953	11	14.8	21.8	23.5	24.2	25.2	25.5	25.8	25.5	22.9	17.2	13.7	20.925	5.2917	0.2529
1954	10	16	18.4	24.6	25.1	25	26	26.1	25.9	22.5	15.8	12.8	20.683	5.7909	0.28
1955	11	12.1	19.8	21.8	24.6	25.7	25.6	25.6	25.6	24.3	18.8	11.8	20.558	5.8609	0.2851
1956	11.2	11.8	19.7	23.1	25.7	25.5	25.9	26.2	25.8	24	18.6	12.8	20.858	5.9158	0.2836
1957	13.1	13.5	17.4	22.9	25.7	25.1	26.5	26.6	26.2	22.8	16.5	12.7	20.75	5.6762	0.2736
1958	12.6	14.8	18.8	24.5	26	27	26.4	26.4	26.3	24.4	18.5	14	21.642	5.5216	0.2551
1959	12.2	13.5	18.9	24.3	25	26.2	26.1	26	25.5	23.3	16.9	12.7	20.883	5.6738	0.2717
1960	10.5	14.6	18.2	24.2	25.7	26.2	25.9	26.6	26	23.7	16.6	13.4	20.967	5.9021	0.2815
1961	12.3	13.5	22.1	24	25.2	25.5	26	26.2	25.7	23.7	16.4	10.3	20.908	6.0076	0.2873
1962	9.5	14.1	18.1	23.7	23.9	25.9	26.7	26.1	25.8	23.1	16.7	12.3	20.492	6.0679	0.2961
1963	10.6	15.2	18.8	22	24.1	25.9	26.5	26.6	26.2	23.5	17.7	13.5	20.883	5.5852	0.2674
1964	11	15.1	21.2	23.7	24.6	25.7	25.9	26.3	26.1	24.8	19.1	13.8	21.442	5.4176	0.2527
1965	11.8	14.3	18	23.4	25.6	25.6	26	25.4	25.8	23.1	18	14.3	20.942	5.328	0.2544
1966	11.5	14	19.1	24.3	25.7	25.9	26.1	26.3	25.6	22.5	19.3	13.8	21.175	5.4915	0.2593
1967	12.8	15.7	19.4	22.2	25	26	26.4	26.1	25.5	22.8	15.9	13.4	20.933	5.2458	0.2506
1968	12	13.6	19.7	23.2	24	25.1	26.4	26.2	26.5	23.8	18.7	13.8	21.083	5.3888	0.2556
1969	11.8	14.4	20.6	23.6	25.5	26	26.5	25.5	26.3	23.2	18.1	13.9	21.283	5.4075	0.2541
1970	12	15.4	20.5	24.4	25.6	26.2	26.3	26.2	26.2	23.9	18.6	12.9	21.517	5.4865	0.255
1971	12.9	14.5	19.8	23.5	23.7	25.7	25.5	24.6	25.3	24.2	17.3	19.8	21.4	4.4729	0.209
1972	12	12.8	19.7	22.9	25.8	25.8	26.3	25.5	25.8	23.4	18.3	13.4	20.975	5.5743	0.2658
1973	12.4	16.5	19.3	24.7	23.6	25.7	26.2	25.8	25.5	24.1	19.1	14.1	21.417	4.9425	0.2308
1974	12	14.6	19.3	23.5	24.9	25.8	26.2	25.8	25.9	23.6	18.2	14.3	21.169	5.23	0.2471
1975	12.3	15.5	20	23.9	24.6	26	25.6	25.9	25.3	24.3	18	12	21.117	5.3742	0.2545
1976	12.4	16.4	21.3	24.1	23.8	25	25.8	25.4	25.8	23.3	20.1	12.1	21.292	5.0307	0.2363
1977	11.7	14.9	22.1	22.2	23.1	25.2	26.3	26.7	26.1	22.8	20.2	13.2	21.208	5.2153	0.2459
1978	10.6	14.2	18.3	22	23.9	25.7	25.9	26.6	25.7	24.5	19.3	12.5	20.767	5.7	0.2745
1979	12.6	14.1	19.8	23.9	26.3	26.4	26.6	26.5	26.1	23.9	20.8	14.4	21.783	5.3728	0.2466
1980	12	15.3	20.7	25	22.9	26.3	26.1	26.5	26.2	23.4	17.8	15	21.433	5.1727	0.2413
1981	13.4	15.5	19.9	21.9	23.6	26.5	26	26.5	26.1	23.6	18.2	13.6	21.233	5.0182	0.2363
1982	12.3	15	19.2	22.6	25	26	26.9	26.1	25.9	23.4	17.9	13.7	21.167	5.3227	0.2515
1983	12.6	14.5	20.7	22.6	24.5	26.1	26.9	26.3	26.3	23.9	19.5	14.2	21.508	5.2093	0.2422
1984	13.1	15	21	24.6	24.5	25.9	26	26.3	25.4	25.6	18.6	14.7	21.725	5.0487	0.2324
1985	14.5	16.1	22.8	24.7	24.2	26.2	26	26.7	25.9	23.9	18.9	15.3	22.1	4.6	0.2081
1986	13.9	16.3	20.8	22.7	23.9	26.6	26.2	26.7	25.3	23.3	19.8	15.2	21.725	4.5456	0.2092
1987	13.1	16.4	20.7	23.9	24.7	27.3	26.5	26.6	26.6	24.3	20.2	15.2	22.125	4.9397	0.2233
1988	13.7	16.4	20.7	24.5	24.9	25.7	26.6	26.9	26.8	23.9	19.7	16	22.15	4.7014	0.2123
1989	11.4	15.4	20.3	25.1	26	26.3	26.4	26.9	26.1	24.5	18.9	13.4	21.725	5.6569	0.2604
1990	14.3	17.4	19.8	22.8	25.1	26.8	26.1	26.9	26.3	23.6	21.7	16	22.233	4.4301	0.1993
1991	13.9	17.5	21.9	24.4	23.3	26	26.7	26.4	25.8	24.5	19.1	15	22.042	4.5612	0.2069
1992	13.6	16	22.1	25.1	24.2	26.6	25.9	26.4	26.1	23.8	18.7	12.4	21.742	5.214	0.2398
1993	12	16.7	18.8	22.8	23.6	25.8	26.2	26.5	25.7	23.8	19.3	13.8	21.25	5.0323	0.2368
1994	13.1	14.2	21.1	22.9	25.3	26.5	26.7	26.4	25.8	23.4	18.9	12.5	21.4	5.4456	0.2545
1995	11.4	15.8	19.4	24.7	26.4	26.9	26.4	26.5	26.4	24	19.9	13.3	21.758	5.6455	0.2595
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Mean	12.188	14.963	20	23.591	24.721	25.964	26.201	26.223	25.922	23.704	18.508	13.745	21.311		
Std	1.1323	1.2707	1.2793	0.9541	0.9049	0.5365	0.3529	0.4752	0.3612	0.6355	1.3	1.4896	0.4512		
C.V.	0.0929	0.0849	0.064	0.0404	0.0366	0.0207	0.0135	0.0181	0.0139	0.0268	0.0702	0.1084	0.0212		

Table D.41 : Monthly & Annualy Average Maximum Temperature in Celcius

Station :Mymensingh (BMD)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Std.	C.V.
1951	24.5	29.3	32.6	33.9	33.1	31.1	31.1	31.9	31.6	30.1	27.9	26.7	30.317	2.7801	0.0917
1952	25.7	29.4	31.5	33	31	31.7	30.8	31.2	30.6	31.3	28.6	25.8	30.05	2.2901	0.0762
1953	24	28.5	31.4	34.8	32.5	31.5	31.8	32.8	31.5	30.2	28.1	27.7	30.4	2.8936	0.0952
1954	24.7	29.1	33.3	34.4	33.4	30.4	31.3	31.5	31.4	29.8	28.3	25.9	30.292	2.9463	0.0973
1955	24.6	28.4	32.3	33	33	31.2	30.3	30.1	31.1	31.1	28.4	24.7	29.85	2.85	0.0955
1956	24.6	27.7	32	32.7	31.1	29.9	31	31	31.2	30.6	28.7	25.9	29.7	2.4896	0.0838
1957	23.6	25.5	31.3	35.4	33.4	31	31.3	32.2	31.8	30.7	28.8	26.5	30.125	3.4163	0.1134
1958	26.2	26.5	32.6	34.1	32.2	32.5	32.1	30.3	31.8	30.7	29	26	30.333	2.7838	0.0918
1959	24.5	27.1	31.7	33.3	31.5	31.3	31.6	31.6	30.4	28.7	28.2	26.9	29.733	2.6172	0.088
1960	25.6	30.8	30.1	36.1	31.6	31.6	30.5	32.1	30.9	31.6	28.4	26.1	30.45	2.7914	0.0917
1961	26.9	25.7	32.2	34.3	33.1	31.4	32	32.2	31.9	31.6	28.6	24.7	30.383	3.1086	0.1023
1962	24.8	27.8	33.2	33.8	31.6	31.1	32.2	30.5	32.1	30.8	28.7	25.9	30.208	2.8356	0.0939
1963	25.5	29.6	31.5	32.4	30.8	31	31.5	30.9	31	30.1	28.2	26.4	29.908	2.1369	0.0714
1964	24.5	27.9	33.1	31.5	31.6	31	30.6	31.9	30.9	30.2	28.6	25.6	29.783	2.6226	0.0881
1965	25.3	27.2	30.4	32.5	32.8	30.6	30.9	30	30.8	31.1	28.1	26	29.642	2.4359	0.0822
1966	25.2	27.6	32.7	34.9	34.1	30.7	31.9	30.5	31.1	29.7	28.5	25.3	30.182	3.113	0.1031
1967	25.5	29	29.8	32.6	32.3	31	31.6	31.7	30.9	29.9	27.5	25.3	29.758	2.4909	0.0837
1968	24.5	26.8	31.8	33.3	30.9	30.7	30.5	30.9	31.1	30.3	28.5	26	29.608	2.6057	0.088
1969	24.3	27.8	31.7	32.2	32.9	31.0	31.5	30.1	31.3	29.6	28.4	26.2	29.753	2.61	0.0877
1970	23.7	27.4	31.6	33.7	33.7	30.8	30.6	31.3	31	29.4	28.4	26	29.8	2.9927	0.1004
1971	25.0	27.7	31.8	33.1	32.4	30.9	31.3	33.6	31.8	33.6	28.8	25.4	30.455	3.0263	0.0994
1972	24.4	24.6	29.3	31	31.7	31.1	31.9	31.5	31.5	30.4	29.2	25.5	29.342	2.8615	0.0975
1973	24.9	28.7	31.4	34.1	29.8	30.9	33	32.1	31.1	30.4	28.4	25.8	30.053	2.7384	0.0911
1974	24.5	30.2	31.9	30.5	32.2	30.9	32.3	33.7	33.3	33.1	28.4	25.7	30.562	2.9601	0.0969
1975	20.9	28.1	32.6	34.7	31.9	33	29.8	32.4	33.5	29.8	29.2	26.9	30.233	3.7606	0.1244
1976	25	28.9	34.2	33.6	31.4	29.6	30.5	30.1	30.8	30.7	30.1	25.7	30.05	2.6763	0.0891
1977	24.3	27.9	31.6	32.9	31.9	31.0	31.3	31.7	31.6	30.7	28.7	25.8	######	2.6892	0.0898
1978	23.5	27.4	31	32.3	29.7	30.1	31.2	32.6	30.9	32.1	29.3	27.2	29.775	2.6379	0.0886
1979	26.6	27.4	33.1	34.9	33.9	32.4	30.8	31.9	31.6	31.6	30.2	26.2	30.883	2.8187	0.0913
1980	25	26.8	31.3	34.2	30.1	31.6	31.6	31.5	31.6	30.6	30	27	30.108	2.5889	0.086
1981	24.6	27	30.4	29.9	30.3	33	30.7	31.7	31.7	32.7	30.3	26	29.858	2.6428	0.0885
1982	26.2	27	29.7	32.1	33.3	30.5	31.4	31.8	32.3	31.9	28.6	25.3	30.008	2.6497	0.0883
1983	24.5	26.8	30.5	31.8	30.8	32	31.6	30.9	31	30.8	29.8	25	29.625	2.6455	0.0893
1984	24.3	26.8	32	33.4	29.7	30.7	30.6	31.8	30	31	29.3	25.7	29.608	2.707	0.0914
1985	25	26.4	31.8	32.2	32	31.2	30.6	31.8	30.9	31.7	29.3	26.8	29.975	2.5136	0.0839
1986	25.3	27.5	32.5	30.9	32	32.3	31.1	32.6	30.6	29.9	28.8	26	29.958	2.5307	0.0845
1987	26	29.2	30.8	32.5	32.6	32.2	30.7	31	31	31.4	29.6	26.7	30.308	2.1211	0.07
1988	26.1	28.1	29.9	32.5	30.3	31	31.1	30.6	31.6	31.7	29.7	26.9	29.958	1.9741	0.0659
1989	24.1	26.8	31	34.2	32.9	31.2	30.9	31.6	30.5	31.1	29.1	25.4	29.9	3.0184	0.101
1990	25.7	26.9	28.2	30.1	32	31.5	30.9	32.1	31.3	30.5	30.5	27.2	29.742	2.1753	0.0731
1991	24.9	28.4	32.2	32.7	28.5	30.5	32.1	32.2	29.7	31.2	29.1	25.2	29.725	2.6444	0.089
1992	24.5	25.1	31.7	34.7	32.2	32.2	31.5	32.2	32.1	32.1	30.3	26.3	30.408	3.2559	0.1071
1993	22.9	27.2	29.8	31.2	30	30.6	31.1	31.1	30.9	31.1	29.4	27.3	29.383	2.4793	0.0844
1994	25.7	25.1	30.5	32.1	32.2	30.9	32.1	32	31.9	31.4	29.1	26.5	29.958	2.6939	0.0899
1995	24	26.2	30.5	33.5	33.5	31.6	30.6	31.1	31.9	32.2	29	25.8	29.992	3.1102	0.1037
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Mean	24.802	27.584	31.477	33.044	31.865	31.21	31.241	31.563	31.324	30.917	28.937	26.065	30.002		
Std	1.025	1.3391	1.1972	1.4129	1.2863	0.7351	0.6395	0.8607	0.7119	0.9867	0.7007	0.6947	0.3217		
C.V.	0.0413	0.0485	0.038	0.0428	0.0404	0.0236	0.0205	0.0273	0.0227	0.0319	0.0242	0.0267	0.0107		

Table D.42 : Monthly & Annualy Average Minimum Temperature in Celcius

Station :Mymensingh (BMD)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Std.	C.V.
1951	9.1	12.9	17.2	20.2	23.2	25.5	26.1	26.4	26	24.4	19.2	14	20.35	5.926	0.2912
1952	10.1	10.9	16.1	20.9	21.4	26.2	26	26.7	26.2	25.6	21.8	13.3	20.433	6.2799	0.3073
1953	10.1	15.6	19.8	22.8	22.5	25.8	26.3	26.6	25.5	24.2	18.2	14.6	21	5.3655	0.2555
1954	10.5	15	17.8	22.9	24.3	24.9	25.6	26.1	25.4	22.6	16.8	13.7	20.467	5.4172	0.2647
1955	12	13.3	18.9	21.9	24.2	24.7	25.6	25.7	25.6	23.9	19.2	13.9	20.742	5.1796	0.2497
1956	11.3	12.7	19	22.8	24.8	25	25.4	25.3	25.4	23.4	18.9	13.9	20.658	5.3687	0.2599
1957	13.2	14.2	18	22.8	24.6	24.3	25.6	26.4	25.4	22.4	17.5	13.9	20.692	5.0121	0.2422
1958	13.5	14	18.6	23.2	24	25.5	26.2	25.7	25.8	24.2	18.4	14.8	21.158	4.9764	0.2352
1959	12.4	13.4	17.8	23.5	23.4	25.3	25.7	25.8	25.2	22.9	18	14.1	20.625	5.1678	0.2506
1960	11.7	14.8	17.7	23	24.4	25.1	25.4	26.2	25.6	23.7	17.5	14.2	20.775	5.2304	0.2518
1961	13.3	12.9	20.5	23.2	24.3	24.9	25.9	26.2	25.7	23.7	17	12.2	20.817	5.4735	0.2629
1962	10.9	14.6	17.3	22.4	22.3	25.1	26.1	25.5	25.6	22.6	17.9	13.8	20.342	5.2514	0.2582
1963	11.6	14.5	17.9	21.1	23	24.8	25.9	25.9	26	23.2	18.1	14.2	20.517	5.1202	0.2496
1964	10.8	14	19.5	21.9	23.5	24.8	25.4	26.3	25.7	24.7	19.4	14.4	20.867	5.2737	0.2527
1965	12.7	14.3	17.2	22.8	23.8	24.8	25.5	24.8	25.4	23.7	21.2	13.5	20.808	4.9629	0.2385
1966	12.7	13.9	17.4	22	24.2	25	25.9	25.7	25.5	22.4	19.4	14.3	20.703	4.9876	0.2409
1967	12.9	15.1	18.3	20.1	23.6	24.7	26	25.9	25.4	22.9	17.1	14.2	20.517	4.858	0.2368
1968	12.5	12.9	18.2	22.1	23.3	25	26.1	26.2	25.7	23.3	19	13.9	20.683	5.2383	0.2533
1969	11.8	13.4	19.1	22.3	24.8	25.0	26.4	25.2	25.6	23.4	18.7	13.9	20.796	5.28	0.2539
1970	11.8	14.5	18.7	23.2	24.3	25.2	25.6	25.7	25.5	23.6	18.4	13.5	20.833	5.2091	0.25
1971	12.1	14.0	18.4	22.1	23.7	24.9	25.9	25.2	26.1	26.2	17.8	13.8	20.854	5.3516	0.2566
1972	12	12.3	19.3	21.5	24.4	24.9	25.8	25.3	25	22.1	17.8	12.6	20.25	5.3885	0.2661
1973	12	15.4	18.4	23.4	22.9	24.6	25.6	25.2	25.6	23.6	18.7	13.6	20.74	4.9345	0.2379
1974	11.7	13.9	17.4	21.8	23.9	24.9	25.4	25.1	25.9	24.8	18.7	13.5	20.581	5.2898	0.257
1975	12.4	14	18.2	22.1	23.8	25.4	25.3	26.3	25	25.6	18.7	14.2	20.917	5.1733	0.2473
1976	12.1	12.9	18.2	21.9	23.8	25	25.7	25.6	25.5	22.3	18.3	13.7	20.417	5.2136	0.2554
1977	12.1	13.7	18.0	22.0	23.5	24.8	25.4	25.4	25.2	23.8	18.3	13.2	20.458	5.1439	0.2514
1978	12	12.8	16.5	20.7	23.2	25.3	26.1	26.4	25.4	24.2	18.7	12.3	20.3	5.6551	0.2786
1979	12.7	12.7	17.1	22.7	25	25.9	25.8	26.2	25.5	23.4	20.3	14.4	20.975	5.36	0.2555
1980	11.6	13.5	17.9	22.1	23.8	25.1	25.5	25.6	25.4	24.0	18.6	13.0	20.501	5.3607	0.2615
1981	12.1	13.4	17.8	22.0	23.4	24.9	25.3	25.5	25.3	24.0	18.6	12.9	20.438	5.2398	0.2564
1982	12.0	13.6	17.7	21.9	23.6	24.9	25.2	25.4	25.0	23.8	18.7	13.1	20.421	5.1761	0.2535
1983	12.2	14.6	18.9	22.0	23.4	25.8	26.7	26	25.8	24	18.1	12.4	20.824	5.4281	0.2607
1984	11.5	13.5	18.5	22.7	23.4	25.7	25.6	26.4	24.8	23.9	17.2	13.1	20.525	5.4839	0.2672
1985	12.6	14.7	20.9	22.1	23.3	25.6	25.8	26.7	25.5	22.9	17.3	14.2	20.967	5.0202	0.2394
1986	12.6	14.3	18.4	21.5	23.7	26.4	26	26.5	25.1	22.6	19.2	14.7	20.917	5.0125	0.2396
1987	12.6	15.8	19.5	22.9	23.6	26.4	26.3	26.3	26.2	23.9	19.1	14.2	21.4	5.0357	0.2353
1988	12.5	15.6	19.4	23.5	23.7	26.1	26.6	26.3	26.2	23.2	18.5	15.5	21.425	4.9468	0.2309
1989	11.2	13.6	18	23.3	24.9	25.8	26.1	26.4	25.5	23.7	17.3	11.4	20.6	5.9542	0.289
1990	12.3	15	17.7	20.5	23.4	25.6	25.3	25.7	24.9	21.5	18.6	12.2	20.225	5.0613	0.2502
1991	9.8	14	17.8	20.2	23.6	23.9	24.6	25.2	25.4	21.3	15.9	13.5	19.6	5.3025	0.2705
1992	12.9	14	19.3	23.3	23.1	25.4	25.9	26.3	25.4	23.3	17.8	12.1	20.733	5.325	0.2568
1993	11.6	16.3	17.3	21.3	23.2	24.9	26.2	26.4	25.3	23.6	18.9	13.9	20.742	5.043	0.2431
1994	12.7	13.2	18.9	22.3	24.3	25.8	26.2	26.3	25.5	22.7	18.2	12.1	20.683	5.5093	0.2664
1995	10.7	14.5	17.7	22.9	25.2	26.1	25.9	26.1	25.7	23.6	19.6	13.6	20.967	5.5765	0.266
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Mean	11.888	13.963	18.271	22.172	23.727	25.239	25.8	25.914	25.52	23.525	18.458	13.589	20.672		
Std	0.9493	1.0315	0.9661	0.9207	0.73	0.5462	0.4019	0.4942	0.3356	0.9782	1.0654	0.8418	0.3145		
C.V.	0.0799	0.0739	0.0529	0.0415	0.0308	0.0216	0.0156	0.0191	0.0131	0.0416	0.0577	0.0619	0.0152		

Table D.43 : Monthly & Annualy Average Sea Level Atmospheric Pressure in mb

Station :Dhaka (BMD)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Std.	C.V.
1953	1015.1	1014	1008.6	1006.7	1003.5	1000.4	1001.4	1001	1004.6	1009.7	1012.8	1014.6	1007.7	5.5514	0.0055
1954	1013.5	1011.6	1009.7	1005.2	1002.5	999.6	1001	1000.2	1003	1009.1	1013.2	1013.8	1006.9	5.5273	0.0055
1955	1016.8	1010.7	1008	1006.7	1003	999	1000.5	1003	1005.2	1008.6	1010.6	1014.6	1007.2	5.4354	0.0054
1956	1012.8	1011.5	1009	1005.6	1000.8	1000.5	1001.8	1000.6	1003.7	1009.9	1013.3	1015.4	1007.1	5.5434	0.0055
1957	1014.1	1012.7	1010.9	1006.8	1003.4	1000.4	1000.4	1002	1005.3	1010.1	1013.8	1014.9	1007.9	5.5158	0.0055
1958	1015.7	1012.2	1010.1	1007.4	1003.6	1000.1	999	1003.2	1004.2	1008.8	1013.1	1015.5	1007.7	5.7529	0.0057
1959	1015	1012	1009.9	1006.7	1002.7	1001.1	999.9	999.6	1003.3	1009.1	1012.4	1014.1	1007.2	5.6679	0.0056
1960	1015	1012	1010	1005.8	1002.1	1000.3	1001.4	999.7	1004.2	1008.6	1012.5	1013.9	1007.1	5.5683	0.0055
1961	1015	1011.1	1008.6	1005.6	1002.2	1000.7	999.4	1000.1	1002.6	1009	1013.5	1013.9	1006.8	5.7699	0.0057
1962	1009.6	1013.7	1009.4	1006.7	1003.7	999.1	998.9	1002.7	1004	1009.5	1013	1014.8	1007.1	5.4513	0.0054
1963	1014.5	1013.2	1010	1007.7	1004.4	1000.3	999.5	1001.6	1004.9	1010	1013.4	1014.7	1007.9	5.6103	0.0056
1964	1015	1012.7	1009.7	1006.1	1003.8	999.9	1002.5	1000.3	1003.8	1006.9	1011.5	1014.7	1007.2	5.3891	0.0054
1965	1015.4	1011.8	1010.9	1006.8	1003.3	998.9	1000.7	1003.5	1005.2	1009.5	1013.5	1013.2	1007.7	5.4269	0.0054
1966	1014.2	1012.3	1009.9	1005.6	1003.1	1000.1	1000	1001.5	1005.1	1010	1011.7	1012.7	1007.2	5.215	0.0052
1967	1014.6	1011.2	1010	1006.7	1003	1000.8	1000.3	1000	1003.8	1010	1013.5	1015.7	1007.5	5.7792	0.0057
1968	1014.3	1013.4	1008.8	1007.9	1003.5	1000.7	1000.3	1000.6	1005.4	1010.4	1014.6	1014.2	1007.8	5.6513	0.0056
1969	1013.2	1012.6	1010	1007.8	1004.8	1000.3	996.3	1003	1004.5	1010.1	1013	1015.5	1007.6	5.8742	0.0058
1970	1015.3	1013.6	1009.2	1007.9	1003.4	1001.3	999.7	1002.1	1003.8	1007.7	1012	1013.4	1007.5	5.3522	0.0053
1971	1014.3	1011.7	1011.7	1006.9	1004.9	999.7	999.6	1002.2	1004.5	1009.2	1014.1	1014.3	1007.8	5.5667	0.0055
1972	1014.7	1011.8	1010.2	1007.3	1003.6	1001.6	998.7	1002.1	1006.7	1011.1	1012.6	1014.6	1007.9	5.4122	0.0054
1973	1014.4	1013.4	1010.9	1004.9	1004	1000.5	999.8	1002.1	1005	1008.8	1011.6	1014.9	1007.5	5.4767	0.0054
1974	1014.5	1012.5	1013.1	1006.8	1003	1003.7	999.8	1001.7	1004.8	1009.4	1012.8	1014.3	1007.4	5.3537	0.0053
1975	1015.1	1013.1	1009.6	1005.7	1002.6	999.5	1002.3	1001.3	1005.5	1007	1012.1	1014.3	1007.3	5.4071	0.0054
1976	1015.3	1011.8	1008.7	1006.7	1003.6	1001	1000.5	1003.4	1005.4	1009.1	1011.2	1014.5	1007.6	4.9929	0.005
1977	1013.8	1013.3	1011.2	1006.7	1004.9	1001.9	999.3	1001.8	1005.1	1012	1013.2	1015.3	1008.2	5.55	0.0055
1978	1015.9	1015.5	1010.4	1007.8	1002.4	1000.5	1001.7	1000.1	1004.7	1009.4	1013.2	1016.1	1008.1	6.1749	0.0061
1979	1015.5	1013.4	1009.3	1007	1004.2	1000.4	1001.9	1000.5	1005.9	1011.4	1012.3	1015.8	1008.1	5.6315	0.0056
1980	1014.7	1013	1010.3	1005.9	1004.6	1001.4	1000.8	1001.8	1005.5	1009.6	1012.8	1013.6	1007.8	5.1156	0.0051
1981	1015.5	1013.2	1011.6	1007.9	1005	1000	1000.9	1000.6	1006.4	1009.3	1011.3	1016	1008.1	5.6675	0.0056
1982	1015.3	1012.8	1010.9	1007.2	1005.7	1000.3	1000.4	1000.1	1005.3	1011.1	1013.1	1015.2	1008.1	5.7581	0.0057
1983	1016.5	1014	1009.9	1007.3	1005.8	1002.1	1002	1002.3	1005.2	1007.6	1013.4	1015.5	1008.5	5.3197	0.0053
1984	1014.4	1012.9	1009.2	1005.7	1002.7	997.6	1001.5	1000.4	1006.3	1009	1013.8	1013	1007.2	5.7443	0.0057
1985	1015.3	1008.9	1008.2	1004.6	1003.5	998.3	1002.3	1000.8	1005.3	1009.4	1012.5	1014.6	1007	5.4341	0.0054
1986	1015.2	1013.6	1009.1	1006.8	1004.6	999	1001.5	1001.8	1006.5	1010.7	1012.9	1016.3	1008.2	5.7304	0.0057
1987	1016.6	1015.1	1010.4	1007.8	1006.9	1000.2	1000.6	1002.2	1005.5	1010.5	1011.8	1015.9	1008.6	5.7626	0.0057
1988	1014.6	1012.4	1008.6	1007.5	1003.2	1000.6	1001.8	1002.5	1005	1007.3	1012.3	1015.6	1007.6	5.1698	0.0051
1989	1013.9	1012.3	1009.2	1005	1003	1001.4	1001.7	1002.3	1005	1008.5	1014.5	1016.7	1007.8	5.4868	0.0054
1990	1014.1	1013.4	1012.2	1006.3	1004.1	1000	1000.1	1003.7	1005.4	1009.9	1012.2	1015.9	1008.1	5.5374	0.0055
1991	1015.2	1013.6	1009.8	1006.8	1005.2	1001.7	999.9	1001.4	1006.2	1008.8	1014.9	1016	1008.3	5.7132	0.0057
1992	1017	1013.4	1009.5	1007	1005.2	1000.9	1001.9	1002.8	1005.2	1009.1	1014	1016.6	1008.6	5.6511	0.0056
1993	1015.2	1013.2	1011.3	1008.5	1004.6	1001.1	1000.8	1001.8	1005.8	1011	1012.8	1015.1	1008.4	5.4314	0.0054
1994	1013.9	1012.9	1009.4	1007.5	1004.3	999.1	998.8	1001.5	1005.6	1011.1	1014.5	1015.9	1007.9	6.0352	0.006
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Mean	1014.8	1012.7	1009.9	1006.7	1003.8	1000.4	1000.5	1001.6	1005	1009.5	1012.9	1014.9	1007.7		
Std	1.2141	1.1617	1.0867	0.9317	1.1595	1.0879	1.2401	1.1187	0.9292	1.1572	0.9726	0.9855	0.4785		
C.V.	0.0012	0.0011	0.0011	0.0009	0.0012	0.0011	0.0012	0.0011	0.0009	0.0011	0.001	0.001	0.0005		

Table D.44 : Monthly & Annualy Average Sea Level Atmospheric Pressure in mb

Station : Mymensingh (BMD)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Std.	C.V.
1951	1016.3	1012.8	1011	1009.5	1006	1001.3	1000.6	1001.4	1005.6	1008.5	1012.5	1017.9	1008.6	5.8004	0.0058
1952	1016.3	1012.8	1011	1009.5	1006	1001.3	1000.6	1001.4	1005.6	1008.5	1012.5	1017.9	1008.6	5.8004	0.0058
1953	1017.1	1015.2	1010	1008.7	1004.9	1001.8	1001.8	1001.6	1005.4	1010.6	1013.9	1015.7	1008.9	5.7578	0.0057
1954	1014.6	1012.6	1010.9	1006.5	1003.8	1000.4	1001.6	1001	1004.1	1010.4	1014.6	1015	1008	5.6749	0.0056
1955	1018.1	1011.8	1009.2	1007.9	1004.2	1000.1	1000.9	1003.6	1006.1	1009.8	1011.9	1015.9	1008.3	5.6244	0.0056
1956	1013.9	1012.5	1010	1007	1002.2	1001.2	1002.6	1001.3	1004.6	1011	1014.4	1016.5	1008.1	5.6217	0.0056
1957	1015.1	1013.8	1012.2	1008	1004.7	1001.5	1000.9	1002.9	1006.1	1011.4	1015.3	1015.7	1009	5.6229	0.0056
1958	1016.9	1013.5	1011.7	1009.1	1005.2	1001.2	999.9	1003.8	1005.1	1009.8	1014.5	1016.8	1009	5.8931	0.0058
1959	1016.2	1012.9	1011.2	1008.2	1004.2	1002.2	1001.1	1000.5	1004.4	1010.3	1013.7	1015.3	1008.4	5.6891	0.0056
1960	1016	1013.1	1011.5	1007.1	1003.5	1001.6	1002	1000.6	1005	1010	1013.8	1015.2	1008.3	5.6613	0.0056
1961	1016.3	1012.4	1009.8	1006.9	1003.8	1001.8	1000.2	1001	1003.6	1010	1014.7	1014.9	1008	5.8345	0.0058
1962	1014.3	1014.7	1010.7	1008.1	1005.2	1000.3	1000	1003.4	1005.1	1010.6	1014.2	1016	1008.6	5.7061	0.0057
1963	1015.5	1014.1	1011.4	1009.2	1005.9	1001.1	1000	1002.5	1005.5	1011.1	1014.6	1015.8	1008.9	5.7481	0.0057
1964	1015.9	1014.2	1011.1	1007.5	1005.1	1000.9	1003.2	1001.1	1004.8	1008.2	1012.9	1015.9	1008.4	5.5182	0.0055
1965	1016.6	1013	1012.1	1007.6	1004.4	999.9	1001.7	1004.3	1006.5	1011	1015.3	1014.9	1008.9	5.6358	0.0056
1966	1017.2	1013.4	1009.5	1006.2	1003.9	1001.1	1001.1	1002.8	1006.5	1011.2	1013	1014.1	1008.3	5.4932	0.0054
1967	1016.1	1012.7	1011.4	1007.9	1004.1	1001.6	1000.9	1001.4	1005	1011.1	1014.7	1016.7	1008.6	5.9068	0.0059
1968	1015.4	1014.3	1009.8	1008.7	1003.9	1001.1	1001	1001.4	1006.4	1011.3	1015.6	1015.3	1008.7	5.8314	0.0058
1969	1014.3	1013.9	1011	1008.6	1005.5	1001.2	1000.7	1003.5	1005.6	1011.1	1014.2	1016.4	1008.8	5.4433	0.0054
1970	1016.5	1014.9	1009.8	1008.4	1003.9	1002.1	1000.4	1003	1004.6	1009.1	1013.4	1014.3	1008.4	5.5403	0.0055
1971	1015.8	1013.8	1010.7	1007.9	1004.6	1001.1	1000.9	1003.6	1006	1010.3	1015.7	1015.2	1008.8	5.5878	0.0055
1972	1015.7	1013.1	1010.1	1008.7	1005.2	1002.2	999.2	1002.7	1007.5	1014.1	1013.6	1015.5	1009	5.6493	0.0056
1973	1015.6	1014.5	1010.7	1006	1005.1	1000.2	998.6	1002.8	1005.8	1010.9	1014.3	1015.4	1008.3	6.0482	0.006
1974	1014.1	1012.4	1011.1	1006.7	1004.6	1001.2	1001.1	1000.7	1006.4	1009.6	1014.3	1015.4	1008.1	5.4433	0.0054
1975	1015.2	1014.7	1010.6	1006.3	1003.7	1000.7	1002.7	1002.2	1006.7	1008	1013	1015.7	1008.3	5.4343	0.0054
1976	1016.8	1013.4	1010	1007.7	1005.3	1001.6	1001.8	1004.6	1007.1	1009.6	1012.6	1016	1008.9	5.1193	0.0051
1977	1014.4	1014.1	1011.7	1007.5	1005.5	1002.3	999.9	1002.1	1005.5	1012.6	1014.1	1016.1	1008.8	5.6689	0.0056
1978	1016.7	1016.1	1010.6	1008.3	1003.1	1001	1002.2	1000.7	1005.2	1009.8	1013.6	1016.7	1008.7	6.1857	0.0061
1979	1016.1	1013.9	1008.2	1005.8	1004.5	1001.2	1002.3	1001.1	1006.4	1011.8	1013	1016.4	1008.4	5.6778	0.0056
1980	1015.1	1013.5	1010.7	1006.4	1005.4	1001.8	1001	1002	1005.8	1009.9	1013.5	1014	1008.3	5.1752	0.0051
1981	1016	1013.7	1012	1008.6	1005.5	1000.3	1001	1000.7	1006.5	1009.5	1011.5	1016.3	1008.5	5.7502	0.0057
1982	1015.9	1013.2	1011.6	1007.6	1006.1	1000.7	1000.7	1000.4	1005.4	1011.5	1013.6	1015.7	1008.5	5.8525	0.0058
1983	1016.9	1014.4	1010.3	1007.8	1006.6	1002.6	1002.2	1002.7	1005.8	1008.3	1014.1	1015.9	1009	5.3231	0.0053
1984	1015.1	1013.7	1009.8	1006.2	1003.6	1001.3	1001.5	1000.8	1006.6	1009.3	1014.3	1013.5	1008	5.4046	0.0054
1985	1015.8	1014.1	1008.4	1005.1	1004.2	1001.1	1002.7	1001.2	1005.7	1010	1013	1015	1008	5.4463	0.0054
1986	1015.7	1014.1	1009.7	1007.6	1005.3	999.6	1001.8	1002	1006.8	1011.3	1013.4	1016.8	1008.7	5.7628	0.0057
1987	1017	1015.6	1010.8	1008.1	1007.4	1000.7	1001.1	1002.7	1006.1	1011.3	1012.3	1016.4	1009.1	5.755	0.0057
1988	1015	1012.9	1009.1	1008	1003.9	1001.3	1002.2	1002.9	1005.4	1007.8	1013	1016	1008.1	5.145	0.0051
1989	1014.2	1012.6	1009.7	1005.2	1003.5	1002.1	1002.2	1003	1005.7	1009.1	1015.1	1017.2	1008.3	5.4314	0.0054
1990	1014.2	1013.8	1012.6	1006.8	1004.6	1000.5	1000.5	1004.1	1005.8	1010.4	1012.6	1016.2	1008.5	5.476	0.0054
1991	1015.5	1013.9	1010.1	1007.3	1005.9	1002	1000.3	1001.8	1006.6	1009.1	1015.2	1016.3	1008.7	5.6622	0.0056
1992	1017.3	1013.7	1009.4	1007.1	1005.7	1001.5	1002.5	1003.5	1005.8	1009.7	1014.6	1017.2	1009	5.5899	0.0055
1993	1015.8	1013.7	1011.8	1009.2	1005.4	1001.8	1001.4	1002.4	1006.4	1011.4	1013.3	1015.7	1009	5.3786	0.0053
1994	1014.4	1013.6	1010.1	1008.2	1005	999.9	999.6	1002.2	1006	1011.6	1015.2	1016.6	1008.5	5.9919	0.0059
1995	1017	1013.5	1010.8	1007.4	1003.6	1001	1001	1002.4	1006	1010.1	1011.9	1013.4	1008.2	5.3985	0.0054
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Mean	1015.8	1013.7	1010.6	1007.6	1004.7	1001.2	1001.1	1002.2	1005.7	1010.3	1013.8	1015.8	1008.5		
Std	1.0107	0.8793	0.9863	1.0895	1.0157	0.6979	0.9976	1.1345	0.7953	1.2586	1.0491	0.9941	0.3309		
C.V.	0.001	0.0009	0.001	0.0011	0.001	0.0007	0.001	0.0011	0.0008	0.0012	0.001	0.001	0.0003		