RECENT CLIMATIC TRENDS IN BANGLADESH

Keka Ishrat A.[1] , Matin I. [2], Banu D.A. [3]

[1,3,] Department of Physics, University of Rajshahi
[2] Department of Civil Engineering, RUET

E-mail: ishrat_keka@yahoo.com; imatinbd@yahoo.com; dab_dexa@yahoo.com

Abstract : This work is an attempt to study the characteristics of different climatic parameters and the recent climatic trends in Bangladesh by using the surface climatological data at 30 stations for the period of 34 years from 1971 to 2004. The Co-efficient of variation of annual rainfall varies from 14.3% at Satkhira to 30.8% at Chandpur. In analyzing the temperature over Bangladesh, a general increasing trend has been noticed. The annual maximum temperature shows positive trends of +0.023 ᵒC/ year at Barisal. The annual minimum temperature shows positive trends at all stations except Hatiya. Drought analysis has been done throughout the country. The monthly drought analysis shows that the period from November to April is affected by drought. Bangladesh has experienced droughts of major magnitude in 1971, 1978, 1979, 1981, 1982, 1989, 1992, 1994 and 1995. Climatologically Bangladesh was divided in different zones by six different methods. According to Koppen classification, more than 50% of the total stations of the country falls under the 'Tropical monsoon: Hot; seasonally excessive rainfall' type of climate and the remaining 50% falls under 'Tropical savanna: Hot; seasonally dry' type and "Subtropical monsoon: Mild winter; dry winter, hot summer" type of climate.

Key words: Drought, IdM, Ihs, IcD, Annual rainfall assurance (A%), Tropical monsoon and Tropical savanna.

1. Introduction

Climate may be defined as a complex of meteorological conditions, which exists in any given area. Climate of a place plays important role in water resources management, crop management, operations of dams and generation of hydroelectricity planning of location of industrial sites, defense planning, tourism and transport, air pollution studies and in fact almost all spheres of human activity. Bangladesh occupies an area of 144,430 sq. kilometers between latitudes 20°35'N and 26°75'N longitudes 88°3'E and 92°75' E. Climatology deals with the spatial distribution of average values of climatic elements, e.g. temperature, rainfall, pressure and winds, humidity, evapotranspiration and evaporation etc. and their relation to man's activities. The short-term variations of atmospheric conditions are comprised in climatology. In Bangladesh the meteorologists divided the year into the following four principal seasons:

- The cold weather season- December to February;
- The hot weather season- March to May;
- The southwest monsoon season- June to September;
- The post Monsoon season- October to November.

In the country, the variations to climatic elements from place to place are due to the following reasons:
1. The latitudinal extent of the country.
2. The variation in altitude.
3. Varying distance from the sea.
4. Encroachment of desert
5. Extension of seasonal high and low pressure areas in the form of wedge trough.
6. Penetration of different types of storms.

2. Objectives

- To study the rainfall characteristics such as rainfall variability, rainy days, rainfall intensity, heaviest rainfall in 24 hours, rainfall distribution patterns etc.
- To study the temperature characteristics such as mean monthly maximum and minimum temperature, temperature anomaly, seasonal temperature condition.

- To study the drought condition in Bangladesh for individual months, years on the basis of rainfall.
- To study the drought condition in Bangladesh using climatic indexes.
- To divide Bangladesh into different climatic zones by different climatic classification methods.

3. Data collection

For preparing this work, the necessary data have been taken from "Bangladesh Meteorological Department, Climate Division, Agargaon, Dhaka" and these data are recorded from 30 selected meteorological stations of the country for 34 years (1971-2004) which is shown in figure 1.

The distribution of the amount of heaviest rainfall during one month recorded up to 2004 as the selected stations of Bangladesh is shown in Table 1.

Table 1 Heaviest monthly rainfall

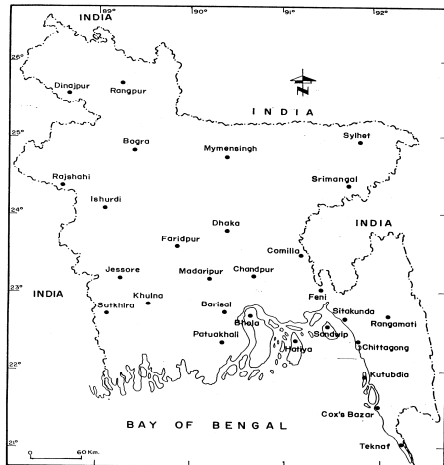| Stations	Amount (mm)	Month	Year
Barisal	1067	Sep.	2004
Chittagong	1457	Aug.	1983
Dhaka	830	Sep.	2004
Khulna	846	Jun.	2002
Rajshahi	644	Sep.	2000
Sylhet	1342	Jul.	1989

Figure 1: Location of meteorological stations in Bangladesh

4. Results and Discussion

4.1 Rainfall Analysis of the Study Area

From the rainfall data mean monthly rainfall and yearly rainfall of the years (1971-2004) have been calculated and has been used for showing rainfall distribution pattern and yearly variation of rainfall. The mean monthly rainfall distributions of Dhaka and Sylhet are shown in figure 2 and figure 3. The graph will help to understand the rainfall pattern of the study area.
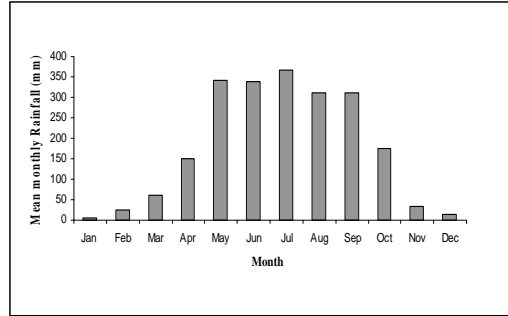

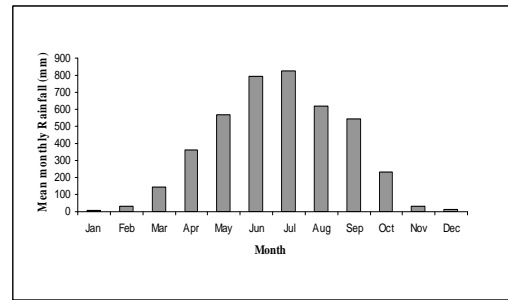**Figure 2** : Rainfall distribution pattern of Dhaka

Figure 3 : Rainfall Distribution pattern of Sylhet

A day is considered as rainy if it experiences the amount of rainfall greater than or equal to a threshold value (Jackson, 1986). This threshold value is not a constant one. In different parts of the world different threshold values are being used. Indian Practice: According to the definition of rainy day given by Indian Meteorological Department the threshold value is 2.5 mm. The annual and seasonal number of rainy days of 5 divisions of the country is shown in Table-2.

Table 2 Number of rainy days

Stations	Hot Weather Season	South-West Monsoon Season	Post Monsoon Season	Winter Season	Annual
Barisal	18	67	9	3	97
Chittagong	18	59	9	3	89
Dhaka	23	66	9	3	101
Khulna	16	57	7	3	83
Rajshahi	13	52	6	3	74

4.2 Temperature

Temperature is an independent variable among the climatic elements whose variation causes corresponding changes in the pressure distribution and consequently in the direction of wind as well as its velocity which controls atmospheric humidity, condensation, formation of cloud and their drafting in the sky, precipitation and storms. The monthly mean maximum and minimum temperature at Dhaka have been shown in figure 4 and figure 5. Variation of annual maximum temperature anomaly at Dhaka has been shown in figure 6.
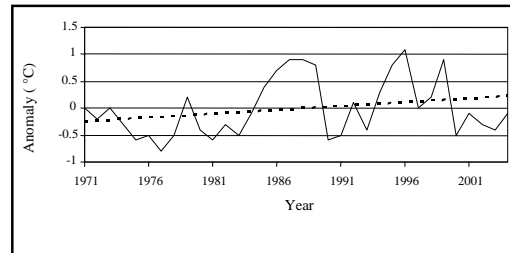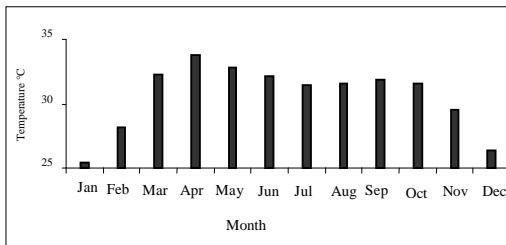

Figure 4: Monthly mean maximum temperature at Dhaka
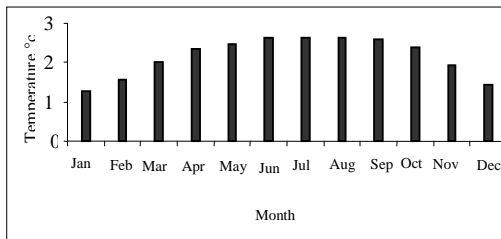
**Figure 5:** Monthly mean minimum temperature at Dhaka

Figure 6: Variation of annual maximum temperature anomaly at Dhaka

4.2.1 Seasonal Temperature Conditions

The distributions of mean maximum temperature of July decreases from west to east of the country. Generally the isopleths of mean maximum temperature of 31°C is confined most regions of the country. The distribution of mean maximum temperature over the country of November is approximately even over the country. The temperature decreases from south to north. The distribution of mean maximum temperature of January decreases from south to north. The most of the isopleths of mean maximum of May are drawn in north to south direction. The temperature gradient of mean maximum temperature decreases from northwest to southeast. Highest value of mean maximum temperature of 34.4°C is recorded at Rajshahi and lowest value of mean maximum temperature of 30.8oC is recorded at Sylhet. Seasonal Temperature Conditions have been shown in figure 7 (A, B, C, D).
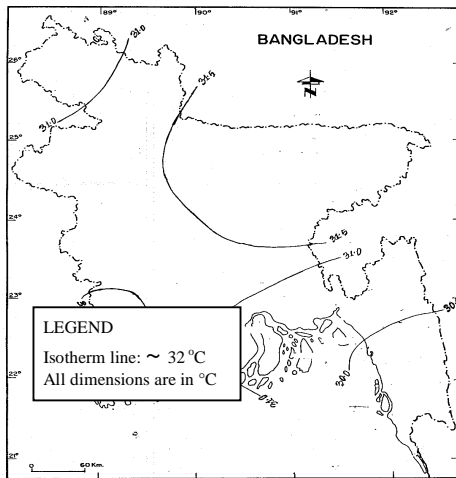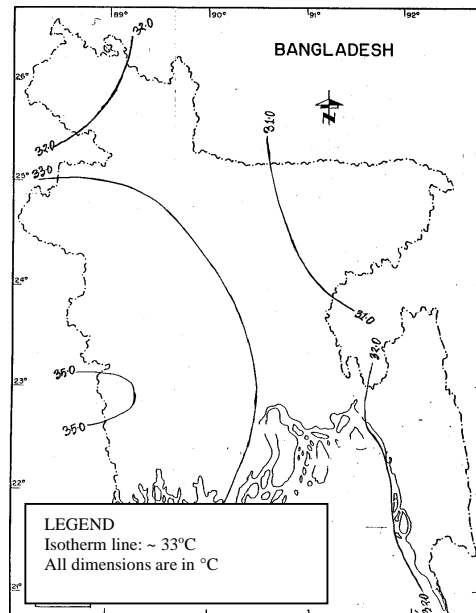
A (July)
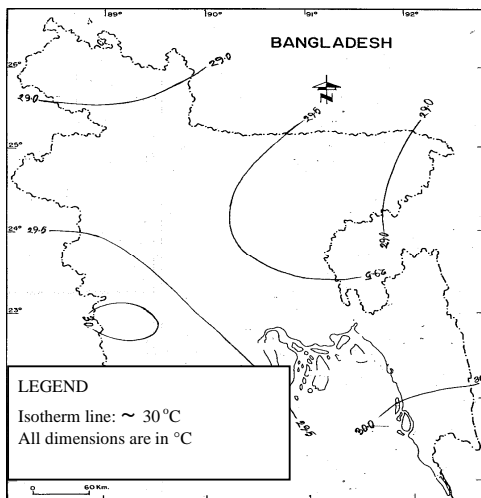
B (November)
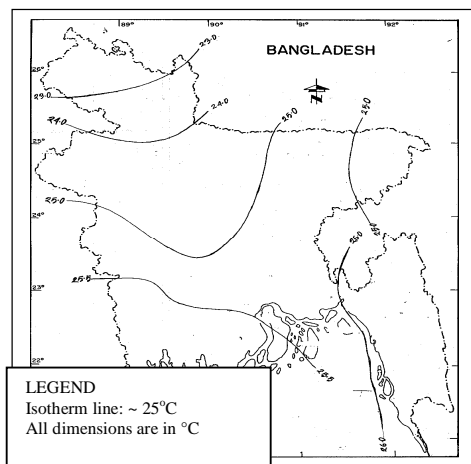
C (January)

D (May)

Figure 7: (A B C D) Mean monthly maximum temperature (^{o}C) at different seasons

4.3 Drought

- Drought is the deficiency of precipitation, river runoff or ground water over an extended period of time, resulting in a water shortage for some activity, group or environmental sector.
- In Bangladesh drought is defined as the period when amount of water is less than the required amount for satisfactory crop growth during the normal crop-growing season.

4.3.1 Causes of Drought

- Drought occurs for lowering of average natural water availability, either in the form of precipitation, river runoff or groundwater.
- Uneven distribution of rainfall may cause drought.
- Inadequate pre-monsoon shower, delay inset of rainy season, early departure of monsoon, rainfall intensity are factors, which cause drought. Other climatic factors are high temperature, high wind velocity, low relative humidity.

4.3.2 Analysis of Drought
1. Yearly Meteorological Drought Analysis
2. Drought Analysis by the Climatic Indexes
   - De Mortone Aridity Index, IdM
   - Seleaninov Hydrothermic Index, Ihs
   - Donciu Climate Index, IcD
   - Domuta Hydroheliothermic Index, IhD

3. Monthly Meteorological Drought Analysis
4. Analysis of Drought by Standard Precipitation Index (SPI)

4.3.3 Results and Discussion
Yearly Meteorological Drought Analysis at different stations (1971-2004) has been shown in table 3.

Table 3 Yearly Meteorological Drought Analysis at different stations (1971-2004)

Stations	Mean Annual Rainfall (mm)	Years having no drought (i.e a.a.r is within 25% deficiency)	Years having moderate drought (i.e a.a.r is in between 25%-50% deficiency)	Years having severe drought (i.e a.a.r is less than 50% deficiency)
Dhaka	2079.85	All the years except 1992, 1994	1992, 1994	-
Chittagong	2707.06	All the years except 1972, 1976, 2001	1972, 1976	2001
Sylhet	4048.76	All the years except 1971	-	1971
Rajshahi	1404.00	All the years except 1972, 1992	1972, 1992	-
Khulna	2190.00	All the years except 1971, 1972, 1975, 1981, 1994	1971, 1972, 1975, 1981, 1994	-

4.4 Climatic classification
This study involves with six types of climatological classification which are given below**:**
1) De Martonne's Climatic Classification
2) Gorczynski's Climatic Classification
3) Russo's Climatic Classification
4) Scheffer's Climatic Classification
5) Koppen's Climatic Classification
6) Thornthwaite Climatic Classification

Analysis of Climatic Classification of Bangladesh by De Martonne's Method De Martonne has defined his Aridity Index as

$$I = \frac{\text{Mean annual precipitation in mm.}}{\text{Mean annual temperature in } °C + 10}$$

The different indices broadly correspond with the following vegetation zones and Results of De Martonne climatological classification have been shown in table 4 and table 5.

Table 4 The different indices broadly correspond with the following vegetation zones:

Aridity Index	Vegetation
Less than 5	Desert
5-10	Dry steppe
10-20	Prairie
20-30	Transition between grassland and Forest
30-60	Forest (Less Vegetation)
60-100	Moderate Vegetation

More than 100	More Vegetation

Table 5 Results of De Martonne climatological classification

Station	Mean Annual Precipitation (mm)	Mean Annual Temperature (°C)	Aridity Index	Remarks
Barisal	2142	25.8	59.92	Less Vegetation
Chittagong	2946	25.9	81.94	Moderate Vegetation
Dhaka	2106	26.0	88.93	Moderate Vegetation
Khulna	1786	26.4	49.13	Less Vegetation
Rajshahi	1532	25.8	42.85	Less Vegetation
Rangpur	2364	24.8	68.03	Moderate Vegetation
Sylhet	4156	25.0	118.74	More Vegetation

5. Conclusion
5.1 Rainfall
- The Co-efficient of variation of annual rainfall varies from 30.8% at Chandpur to 14.3% at Satkhira.
- The Co-efficient of variation (C.V) is inversely proportional to the rainfall.
- Maximum mean monthly rainfall at Teknaf is 1033 mm in July.
- Departure from normal annual rainfall (%) is maximum in southeastern part of Bangladesh.

5.2 Temperature
- The mean monthly maximum temperature attains its peak in April at some stations and some are in May over Bangladesh.
- The mean monthly minimum temperature attains its lowest in January and secondary lowest in February and December over Bangladesh.
- The annual maximum temperature shows positive trends at all stations of the project area except Mymensingh and Sandwip. At Mymensingh and Sandwip the annual maximum temperature shows negative trends are -0.020°C/year and -0.029°C/year respectively
- The annual minimum temperature shows positive trends at all stations of the project area except Hatiya, where the annual minimum temperature shows negative trend of -0.02°C/year.

5.3 Drought

- It has found that from November to March all the study area experiences a drought. Sometimes in the month of April, September and October drought occurred.
- Severe drought occurred in 1971, 1973, 1974, 1979, 1980, 1985 and 2003 in the study area of Chittagong, Cox's Bazar, Kutubdia, Sitakunda, Maizdi Court, Teknaf and Srimongal.
- Moderate drought occurred in the years of 1972, 1976, 1981, 1991, 1992, 1994 and 1995 in the study area of Mymensingh, Comilla, Chandpur, Feni and Rangamati.

5.4 Climatic Classification
- From De Mortonne climatological classification 3 stations are of more vegetation, 17 stations are of moderate vegetation and 14 stations are of less vegetation. The more vegetation stations are Cox's Bazar, Teknaf and Sylhet.
- By Scheffer's method if climate index is high then the decay of wood structures on earth surface also be high. The highest dacay of wood structures is found in Srimangol and the lowest is found in Chuadanga
- According to Koppen Classification, more than 50% of the total stations of the country falls under the "tropical monsoon: Hot-seasonally excessive rainfall" type of climate and the remaining 50% falls under "Tropical savanna: Hot; seasonally dry" type

and the "Subtropical monsoon: Mild winter; dry winter, hot summer" type of climate.

- Most of the area of Bangladesh comes under the tropical and humid zone according to Thornthwaite classification.

Acknowledgement

6. References

[1] Ananthakrishnan, R. (1970): "Some salient features of the space-time variation of rainfall over India and neighborhood," Current Science, 39 (5) pp 101-105.

[2] Awasthi, A. (1995): "Indian climatology", APH Publishing Corporation, New Delhi.

[3] Chandra, D.G. (1989): Fundamentals of agronomy, Oxford & IBH Publishers Co. PVT. Limited, New Delhi.

[4] Critchfield, H.J. (1987): General climatology, Prentice Hall of India Private Limited, P.P 145-154.

[5] Garg, S.K. (1976): Irrigation engineering and hydraulic structure, Khanna Publishers, India.

[6] Gupta, B.L. and Singh, N. (1981): Some finding of rainfall in Rajasthan, Geographical review of India, Vol. - 43, No. - 4.

[7] Islam A.K.M.N., Hoque, A.E., and Nazrul, A.S. (2008): Role of green plants in climate change mitigation, Proceedings of National Seminar on Renewable Energy.

[8] Islam, M.A. et. al. (1981) : River system, Bangladesh in Maps, Dhaka.

[9] Main, M.A., Miyan, M.A.A. (1994): An introduction to statistics, Ideal Library, Dhaka, Bangladesh.

[10] Matin, I. and Fariduddin, A.K.M. (1989): Behavior of climatic parameters over Bangladesh, 5th Bangladesh National Geographical Conference.

[11] Michael, A.M. (1981): Irrigation theory and practice, Vikas publishing house Pvt. Ltd. New Delhi, India.

[12] Modi, P.N. (1988): Irrigation, water resources and water power engineering, Standard Book House, India.

[13] Mukerjee, K.S., Khaur and Mehra, A.K. (1991): Applicability of extreme value distribution for analysis of rainfall over India, Mausam, 42, 1, 29-32.

[14] Rahman, M.M., Azam, M.M and Choudhury M.G.M. (1998): Prelimanary evaluation of wind power potential in Bangladesh, The Nucleus, 35 (3-4).

[15] Rashid, H.E. (1977): Geography of Bangladesh, University Press Limited, Bangladesh.

[16] SAARC Meteorological Research Centre (2000): Climatic variability and its trend in Maldives".

[17] SAARC Meteorological Research Centre (2000): Recent climatic changes in Srilanka, SMRC - No.5, Dhaka, Bangladesh".

[18] SAARC Meteorological Research Centre (2001): Recent climatic changes in Bangladesh, SMRC- No.4, Dhaka, Bangladesh.

[19] Scheffer, T.C. (1972): A climate index for estimating potential decay in wood structures above ground, Forest Prod. J.21 (10): 25–31.

Appendix

For the meteorological station Dhaka:

Total Rainfall for 33 years = 68,935 mm.

Average Rainfall per year = $68{,}935 \div 33$

$$= 2088.9393 \text{ mm.}$$

In 1971, Annual Rainfall = 1,922 mm.

Percentage value = $1{,}922 \div 2088.9393 \times 100$

$$= 92\%$$

Annual Rainfall Assurance (A %) = 150-92

$$= 57 \%$$

Dr. Ishrat Ara Keka

Dr. Ishrat Ara Keka was born in Rajshahi city of Bangladesh. She passed S.S.C examination from Govt. P.N. Girl's High School, Rajshahi and H.S.C from Rajshahi College, Rajshahi. She secured her B.Sc (Hons) and M.Sc degrees from Physics Department in Rajshahi University, Bangladesh. In M.Sc class her special branch was Nuclear Physics. After that she secured her M.Phil and Ph.D degree from the same department. The field of her research was Atmospheric Physics. Several times she attended in different National and International seminars. She was awarded for her presentation on the seminar. She is a member of Bangladesh Physical Society. In her study life there is publication "Analysis of Drought in Eastern Part of Bangladesh" – D.I.U journal of Science & Technology Vol-7, Issue 1 January 2012. At present, she acts as a Principal in an English medium school at Rajshahi. She has two children named Kuhu and Kushol.

Iqbal Matin

Iqbal Matin is currently a Professor and Head of the Department of Civil Engineering, Rajshahi University of Engineering & Technology, Bangladesh. He had over 32 years of teaching and research in the field of Water Resources Engineering. He is author and co-author of several books published from Bangladesh and India. He is a profile writer of science based articles which have been published in national and International journals and newspapers. A number of students got their M.Sc. Engg. and Ph.D. degree under his supervision.

Dilruba Akhtar Banu

Dilruba Akhtar Banu is an Associate Professor in the department of Physics in Rajshahi University, Bangladesh. Her areas of interest include Environment Physics and Medical Physics. In her study life there are some publication such as: (i) "Black selective surfaces for solar photo thermal conversion" – Nuclear Science and Application A.R.C Vol-12, no.1, 2 December 2003; (ii) "Studies on Bone Mineral density in some people of Bangladesh"- D.I.U journal of Science & Technology.