Variability and trends of rainy days in Bangladesh

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Abstract

The impact of climate change on annual rainy days has received a great deal of attention by scholars worldwide. Many studies have been conducted to illustrate that changes in annual rainy days is becoming evident on a global scale. In the present study fifty years (1950-1999) daily rainfall data of 13 meteorological stations of Bangladesh Meteorological Department (BMD) have been used. Seasonal and yearly trend of rainy days are studied. Variation of three threshold rainy days named: Moderated Heavy, Heavy and Very Heavy are also studied. The country is divided into two regions named: wet region and dry region. All the stations show positive trend of yearly variation of rainy days except in Srimongal (situated in northeastern part of Bangladesh) during 1950-1999. All the four seasons (winter, pre-monsoon, monsoon and post-monsoon) showed positive trend of rainy days during the study period 1950-1999. The country's averaged three threshold rainy days showed positive trend. The wet (dry) region showed negative (positive) trend of rainy days during 1950-1980 whereas wet (dry) region showed positive (negative) trend of variation of rainy days during 1981-1999. The country's averaged rainy days showed negative trend during 1950-1980 and positive trend during 1981-1999. These changes indicate that the climate of Bangladesh is changing. The yearly averaged increase of rainy days was 0.36 days/year.

Keywords: Bangladesh; Trend of rainy days, Climate change

1. Introduction

Rainfall is the most dominant element of the climate in Bangladesh, which has strong impact on life and economy. Excessive of rainfall causes widespread flooding, flash flooding and on the other hand its lack leads to drought. Timely and well-distributed rainfall is essential for better crop production while the erratic behavior of rainfall has an adverse effect. One of the most important parts of the water resource comes from rainfall. Two-thirds of the global precipitation occurs in the tropics. It has been well documented that rainfall on the Earth's surface varies greatly in both time and space. The south Asian monsoon system, in terms of rainfall, is of great importance to climate researchers for understanding its variability at different space and time scales. In recent years interest has increased in learning about precipitation variability and predictability. Another important aspects of rainfall is to changes in climate extremes (e.g., floods, droughts, etc.) since these events have the strongest impact on society. It has been documented that even a small change in the mean condition can cause a large change in extreme statistics [1]. Consequently, the degree to which climate change affects society will more likely depend on changes in climate variability and particularly, in the intensity, frequency, spatial and temporal distribution of climate extremes [2].

In Bangladesh, the agricultural economy with large growing population is closely linked with the behavior of rainfall distribution. The inter-annual variability of rainfall is very high, which

significantly affects the agricultural activities and other water based enterprises in Bangladesh. Abnormalities of rainfall may be manifest in several forms like as less rain, rain not commencing in time due to delay in the onset of summer monsoon or early cessation due to early withdrawal of monsoon season.

Guhathakurta et al. [3] studied the impact of climate change on extreme rainfall events and flood risk in India. They showed that the frequency of rain days, rainy days and heavy rainfall days showed significant decreasing trends over central and many parts of north India; and increasing trends over peninsular India. Islam et al. [4] compared rainfall and rainy days using TRMM 3B42 and rain gauge data for the period 1998-2002. Out of 274 days, averaged for 5 years rainfall over 31 stations, 97.08% and 98.91% days are detected as rainy days by TRMM and rain gauge, respectively. Rainy days detected by TRMM matched 95.99% of same detected by rain gauge.

However still to date it is not clear the long term variability of rainy days and extreme rainy days which are the indicators to monitor climate change impact in Bangladesh.

2. Methodology

In this study daily rainfall data of 13 meteorological stations of Bangladesh Meteorological Department (BMD) named: Comilla, Chittagong, Cox's Bazaar, Khulna, Jessore, Satkhira, Sylhet, Mymensingh, Srimongal, Rangpur, Bogra, Dinajpur and Dhaka have been used (Fig.1). The study period was 1950-1999.

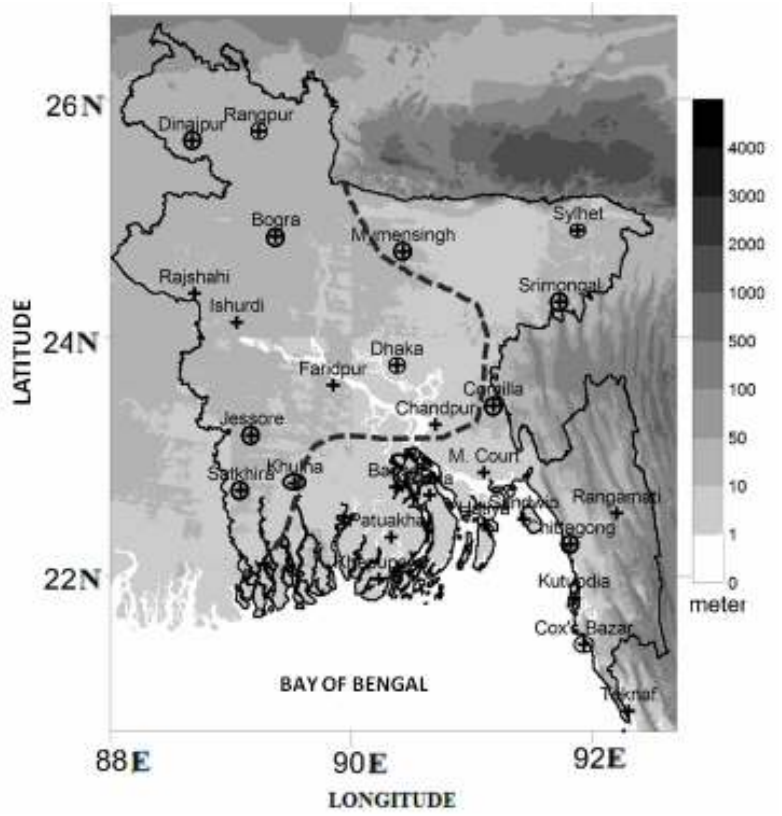

Fig. 1: The names of the BMD observational site over Bangladesh are shown above the station location (plus mark). The circles with plus mark indicate the stations which are used in detail study, and left side of dash line is dry region and right side is wet region. Topography is shown by grey shading.

Variations of rainy days were calculated for individual station from daily rainfall data during the period 1950-1999. Rainy days were calculated using command =COUNTIF(data range,">01mm") in the Microsoft Excel program. Rainy days were also calculated for winter, pre-monsoon, monsoon and post-monsoon seasons. According to BMD, the moderated heavy rain is defined as 22 mm < M. Heavy Rain ≤ 44mm. The heavy rain is defined as 44mm < Heavy Rain ≤ 88mm and the very heavy rain is defined as V. Heavy Rain >88 mm rain in 24 hours. These three threshold rainy days are also calculated from daily rainfall data.
The whole country was divided into two regions named: wet and dry regions (Fig. 1), based on humidity anomalies as proposed by Islam and Uyeda [5]. The rainy days were also calculated for wet and dry regions.

3. Results

All the stations showed increasing trend of yearly variation of rainy days except Srimongal during 1950-1999 in Bangladesh. Dhaka, Comilla, Chittagong, Cox's Bazar, Khulna, Jessore, Satkhira, Sylhet, Mymensing, Rangpur, Bogra and Dinajpur stations showed positive trend of yearly variation of rainy days with maximum value 151, 145, 139, 150, 137, 130, 131, 175, 148, 129, 137 and 121 in 1980, 1991, 1952,1952, 1990, 1964, 1997,1990, 1998, 1987, 1991 and 1987 and minimum value 95, 78, 100, 85, 50, 66, 72, 131, 61, 81, 76 and 58 days in 1972, 1950, 1960, 1972, 1969, 1972, 1972, 1979, 1975, 1976,1972, 1989 and 1954, respectively (not shown). Srimongal station showed negative trend of yearly variation of rainy days with maximum value 173 in 1953 and minimum 82 in 1975 (Fig. 2). The highest positive trend of value 1.1078 is observed for the station of Khulna and lowest is 0.0065 for the station of Chittagong. The negative trend of yearly variation of rainy days of value -0.0459 is observed for the station of Srimongal.

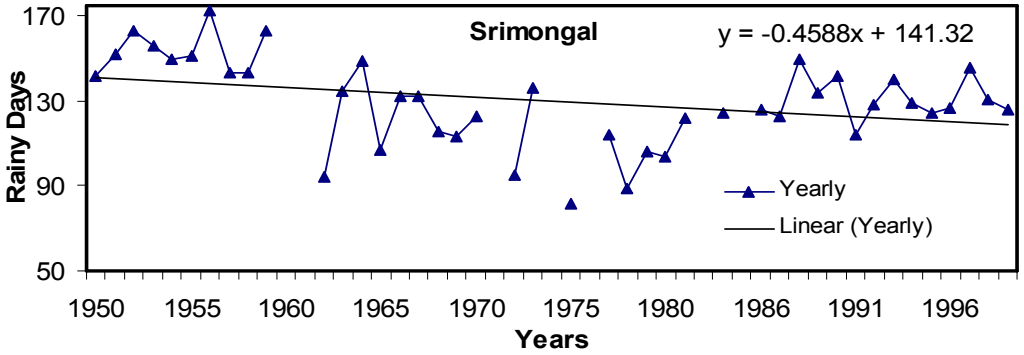

Fig. 2: Yearly variations of rainy days for Srimongal stations during 1950-1999.

Rainy days showed positive trend for winter, pre-monsoon, monsoon and post-monsoon seasons during 1950-1999 (Fig. 3). The maximum and minimum trend of rainy days is observed in pre-monsoon and post-monsoon season, respectively. In winter, pre-monsoon, monsoon and post-monsoon periods, the maximum value of rainy days of 08, 33, 84 and 16 are found in the year 1997, 1990, 1997 and 1975, respectively. In winter, pre-monsoon, monsoon and post-monsoon periods, the minimum value of rainy days of 00, 07, 59 and 03 days are found in the year 1960, 1971, 1972 and 1981, respectively. The seasonal average rainy days of 04, 22, 76 and 10 are found in winter, pre-monsoon, monsoon and post-monsoon seasons, respectively.

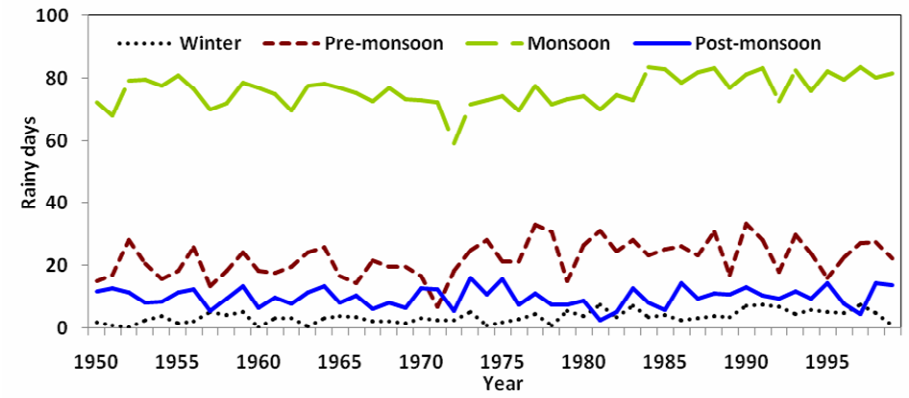

Fig. 3: Seasonal variation of rainy days during 1950-1999.

Fig. 4 showed positive trend of moderated heavy rainy days with maximum value 23 in 1993 and minimum value 10 in 1972. Fig. 4 showed positive trend of heavy rainy days with maximum value 15 in 1984 and minimum value 07 in 1992. Fig. 4 also showed positive trend of very heavy rainy days with maximum value 06 in 1987 and minimum value 01 in 1957. The highest increasing trend is found for moderated heavy rainy days whereas lowest increasing trend is found for very heavy rainy days.

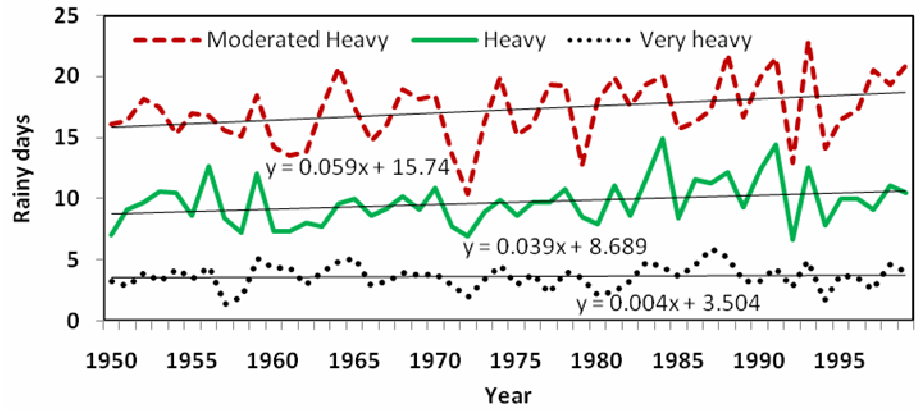

Fig.4. Yearly variation of rain days for moderated heavy, heavy and very heavy.

The wet and dry regions showed positive trend of rainy days with maximum value 146 and 126 in the year 1988 and 1990 and minimum value 70 and 76 in the year 1971 and 1957 during the study period 1950-1999, respectively. The increasing trend of rainy days in the wet region is less than that of in the dry region. The average rainy days in wet and dry regions are 120 and 103 days, respectively. The wet and dry regions showed negative and positive trend of rainy days during the period 1950-1980, respectively (Fig. 4). Whereas the wet and dry regions showed positive and negative trend of rainy days during the period 1981-1999, respectively (Fig. 4). These changes may be due to climate change impact in Bangladesh as proposed by Rahman [6]. He showed that a significant increase of rainfall in Bangladesh after 1980's using Cramer test. These indicate that the wet region gets more rain whereas dry region gets less rain due to impact of climate change in Bangladesh after 1980's. These changes may affect agriculture sectors severely in long run in Bangladesh. The trend of average rainy days is -0.07 during 1950-1980 and 0.24 during 1980-1999.

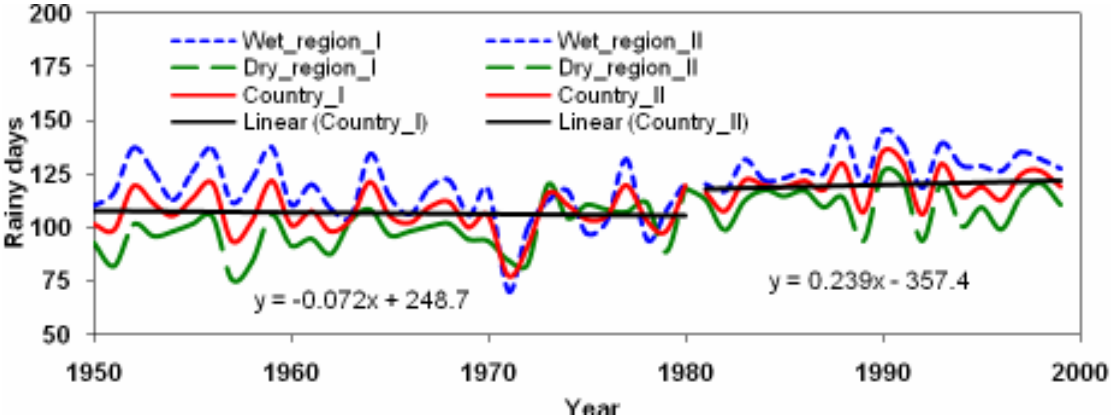

Fig. 5: Variation of rainy days for wet and dry regions, and country's averaged during the period 1950-1980 (phase I) and 1981-1999 (phase II).

4. Discussion and Conclusions

Daily rainfall data of 13 meteorological stations of Bangladesh Meteorological Department (BMD) for the period 1950-1999 have been used in this study. All the stations showed positive trend of rainy days except Srimongal (situated in the northeastern part of Bangladesh). Seasonal trend of rainy days also showed positive trend during 1950-1999. About 03.57, 19.64, 67.86 and 08.93 % of total yearly rainy days are found during the winter, pre-monsoon, monsoon and post-monsoon seasons, respectively. About 04.44, 23.91, 62.30 and 16.39 % of total seasonal days are found rainy during the winter, pre-monsoon, monsoon and post-monsoon periods, respectively. The moderated heavy, heavy and very heavy rainy days are also showed positive trend. The wet (dry) region showed negative (positive) trend of rainy days during 1950-1980 whereas wet (dry) region showed positive (negative) trend of variation of rainy days during 1981-1999. The country's averaged rainy days showed negative trend during 1950-1980 and positive trend during 1981-1999. The yearly averaged increase of rainy days was 0.36 days/year.

It is apparent that rainy days are changing in different seasons, most of the stations, regions and country's averaged show positive trend which lead to change our climate.

On fitting the linear trend line, it is observed that trend is increasing for all the stations, except for Srimongal. For Srimongal, the trend apparently is decreasing. The slope of the trend line is not very large in magnitude for all the stations, but it is positive. Based on the above results, it is of immense importance to discuss the ecological, economical, agricultural and social impacts that could result if increasing rainy days trends continue in these stations in the future. Excess rainy days could also lead to soil saturation and soil erosion problems.

On the other hand, Srimongal experienced a decreasing rainy days trend during the 50 years time period of this study and if this trend continues in the future then it could have repercussions in the sustainability of surface water resources and groundwater recharge.

5. Acknowledgements

The authors would like to thank to Bangladesh University of Engineering & Technology (BUET) for all kinds of help to carry out this work. The authors also thank the Bangladesh Meteorological Department for providing the daily rainfall data.

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