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Study on the variability and trend of rainfall in Bangladesh

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ABSTRACT

Now a day, global warming has induced changes in precipitation in different regions of the world. Bangladesh is recently experiencing climate change impact related to hazards like cyclone, flood, draught etc. Climate variable like rainfall is the most important parameter which is linked with agricultural aspects too. Most of the rain occurred during monsoon period in Bangladesh. The study on rainfall trend over the country has done using observed station data of Rainfall (In-situ) collected from Bangladesh Meteorological Department (BMD). These data have been analyzed based on annual and seasonal variation in Bangladesh for last 6 decades. A set of analysis has been carried out for this study. Linear trend lines show the rainfall trend over Bangladesh which is not very significant. The annual and monsoon rainfall is found in decreasing trend in recent times (1981-2010) whereas in increasing trend during the period of 1951-2011. The time series statistical analysis of this study will provide information about annual and seasonal mean total rainfall and rainfall variation over the country for different decades, as well as the rainfall trend in different divisions of Bangladesh in different times. The result of this study will help the policy makers to take necessary steps and measure in different sectors like disaster management, agricultural production, drought mitigation, flood control etc. and to act against the adverse impact of climate change. In this paper, annual, seasonal and divisional rainfall variability and trend analysis over Bangladesh will be discussed.

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Introduction

Bangladesh is one of the most vulnerable countries often faced with natural calamity. It is situated at the interface of two different environments, with the Bay of Bengal to the South and Himalayas to the north. Due to its geographical position, Bangladesh experiences highest amount of country average monsoon and annual rainfall among SAARC countries (Devkota, 2006). It has four climatic seasons from the meteorological point of view. They are: Winter (December–February), Pre-monsoon (March–May), Monsoon (June–September) and Post-monsoon (October–November). The country experiences a hot summer of high humidity from late March to late June, a somewhat cooler but still a hot and humid monsoon from late June through October and a cool dry winter from November to the end of February. The rainfall of Bangladesh is mainly governed by the activities of southwest summer monsoon system (i.e., position and intensity of monsoon trough), tropical cyclonic disturbances, local land origin weather systems (land depressions, thunderstorms and mesoscale convective systems) and sub-tropical western disturbances (Ahasan et al, 2010). The mean annual rainfall is about 2320mm, but there are places with a mean annual rainfall of 6000mm or more (Hossain et al., 1987). Now a day, erratic rainfall becomes very common in Bangladesh. Such phenomena and their associated extreme events may affect ecosystems, productivity of land, agriculture, food security, water availability and quality, health and livelihood of the common people of Bangladesh. Therefore, a better understanding of precipitation variations has important implications for the economy and society of Bangladesh (Shahid .,S, 2011).

Rainfall pattern is changing due to global warming in recent times although the exact degree of change is not yet determined. Being one of the most vulnerable countries of climate change induced disasters; Bangladesh is facing some basic and major changes in its climatic behavior and weather pattern. Hence, the present study focuses on the spatial and temporal (inter-seasonal and inter-annual) variability and trends of rainfall due to climate change, in more details over Bangladesh by using up-to-date data sets covering the period 1951-2010. The annual, seasonal and divisional rainfall are calculated on the basis of the monthly rainfall In-situ Data.

Study area

Bangladesh occupies an area of 143,998 km has a sub-tropical humid climate with it's unique location of Indian Ocean to the south, the Himalayas to the North. Geographically, it extends from 20°34'N to 26°38'N latitude and from 88°01'E to 92°41'E longitude. Except the hilly southeast, most of the country has low-lying plain land. Climate of Bangladesh is characterized by wide seasonal variations in rainfall, moderately warm temperatures, and high humidity. (Rashid, 1991). The average temperature of the country ranges from 7.2°C to 12.8°C during winter and 23.9 to 31.1°C during summer. The average relative humidity for the whole year ranges from 70.5% to 78.1% with a maximum in September and a minimum in March (Shahid .,S, 2011). But it is changing due to global warming.

Objective

The overall objective of this paper is summaries as follows:

To monitor the annual rainfall variation and trend for different decades ; to observe seasonal rain trend; to analyze the variation of rain in diff divisions; to compare the mean total with normal rainfall ; to study the climate change in recent days and

to gather information on the effect of climate change on rainfall pattern and variability.

Data used

The updated divisional and monthly rainfall data of 60 years (1951-2010) provided by Climate Division of Bangladesh Meteorological Dept.(BMD) have been used in this study. These data are the field data collected by 34 rain gauge stations of BMD having their respective Lat/Long. The stations are selected on the basis of uniform spatial distribution and availability of maximum data length and data accuracy. The available rainfall data are, the daily recorded at the stations for 50 years (1951-2000) and monthly rainfall data for 10 years (2001-2010). These observed data are subjected to a visual inspection and the suspected data were deleted and marked as blank. These suspected data points and missing entries were filled up by inverse square distance weighted interpolation technique. The location of the rain gauge stations selected for this study is shown in Figure 1.



Figure 1: Location of 34 BMD stations

Methodology

Data preparation and processing

The observed divisional and monthly rainfall data of the period 1951-2010 (60 years) were collected from the Climate Division of Bangladesh Meteorological Department (BMD). The annual and seasonal mean total rainfall as well as the deviations are calculated using those monthly In-Situ data and were plotted. It may be noted here that for the computation of seasonal values for the winter season, the data of December for one year has been used with the data of January and February of the following year to represent the winter value of the following year and similar method is applied for all other seasons (Ahasan et al, 2010). Throughout this study, the mean total rainfall is referred as country average that means the average rainfall of all divisions of Bangladesh.

Results and Discussion

Bangladesh is situated at the interface of two different environments, with the Bay of Bengal to its one side and Himalayas to the other. Due to its geographical position, Bangladesh experiences highest amount of country average monsoon and annual rainfall (Devkota, 2006). The rainfall of country is mainly governed by the activities of southwest summer monsoon system (i.e., position and intensity of monsoon trough), tropical cyclonic disturbances, local land origin weather systems (land depressions, thunderstorms and mesoscale convective systems) and sub-tropical western

disturbances. The results of the present study on the variability and trend of rainfall over Bangladesh have been analyzed and discussed in the subsequent sub sections.

Annual rainfall analysis

Statistical analysis has been undertaken to analyze countrywide temporal rainfall variation and trend. Data have been organized in terms of annual and four seasons as pre-monsoon, monsoon, post-monsoon and winter.

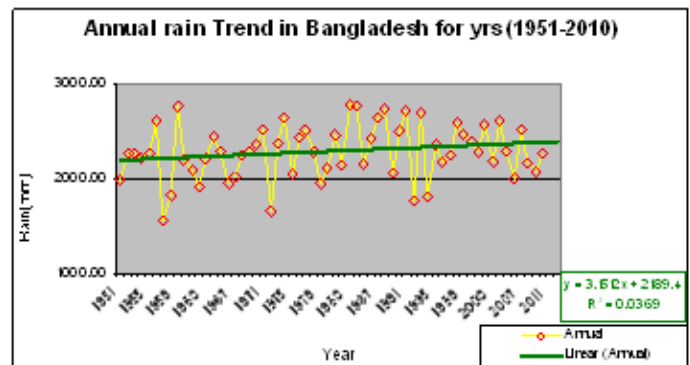


Figure 2a: Increasing Annual Rain Trend in Bangladesh during 1951-2010

Time series data sets were used for this study. Annual mean total rainfall over Bangladesh during the years (1951-2010) are shown in Figure 2a. Data series have been applied for linear trend, so that it should be consistent for sixty years period and to determine any significant change of trends for selected parameter (rainfall) of different seasons and divisions. The sets of analysis that were carried out for the rainfall data series were intuitively focused towards examining any discernable trends in these time series. An increasing trend of about 0.032mm per year is found (Figure 2a).

However, over the last 30 years (1981-2010), the trend is found to be decreasing at a rate of 0.069 mm/year (Figure 2b).

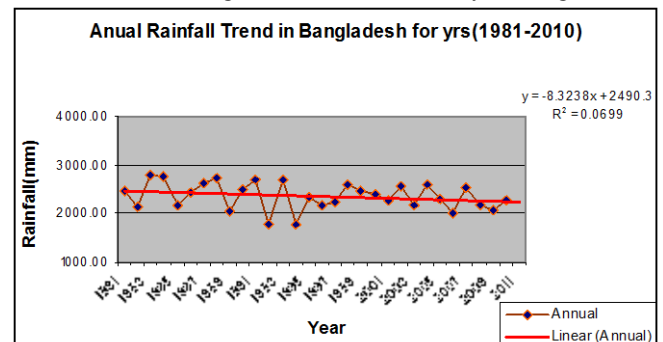


Figure 2b: Decreasing Annual Rain Trend in Bangladesh during 1981-2010

Seasonal rainfall analysis

Extreme southeast part of Bangladesh receive more than 82% of the annual rainfall during monsoon season which is the highest over Bangladesh. The Lowest percentage of annual rainfall during monsoon season occurs at Srimangal over Bangladesh which is about 60-62% (Ahasan et al, 2010).

The rainfall data for 60 years (1951-2010) were again analyzed to study the seasonal rainfall variation and trend within the country (Figure 3a). It is seen from analysis that the rainfall occurred maximum in monsoon season and minimum in winter. It is also observed that the variation in rainfall is also found maximum in monsoon. The window of maximum variations are found as for the years (1957-1960),(1973-1978),1993-1996) and (2005-2010).

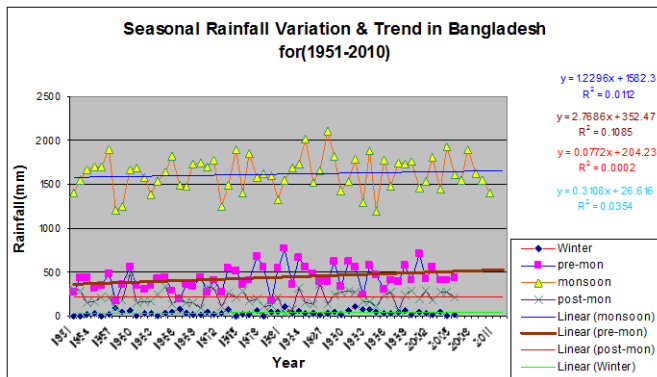


Figure 3a: Seasonal rainfall variation and trend over Bangladesh for yrs. 1951-2010

The time series plot of seasonal rainfall in Bangladesh reveals that the country average shows the inter-annual variability. It is also found that the time series of 5 year moving average reveals existence of low frequency variability of time scales of 9-14 years. The time series of Bangladesh monsoon rainfall shows that there were 12 strong monsoon years and 10 weak monsoon years within the period of 1951-2010 (60 years). The summer monsoon is the main rainy season in Bangladesh which accounts for about 72 percent of the annual rainfall during summer monsoon season (Ahasan et al, 2008).

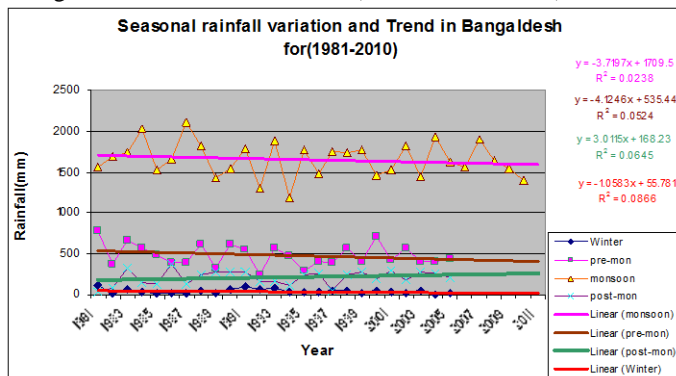


Figure 3b: A trend analysis over Bangladesh during the last 30 years (1981-2010)

A trend analysis over Bangladesh during the last 60 years (1951-2010) shows an increasing trend for all seasons (Figure 3a). For monsoon season, the linear trend line is in increasing trend of about 0.0112 mm/yr, whereas the trend of the last 30 years (1981-2010) is found to be decreasing at a rate of 0.0238 mm /yr (Figure 3b).

Interestingly, the trend analysis for last 30 years (1981-2010) shows decreasing trend for all seasons except post-monsoon. That means, rainfall is decreasing in recent days due to climate change.

Divisional rainfall analysis

To analyze the divisional rainfall variability and trend for last decades, we only consider the monsoon season as maximum rain occurred during this period (Figure 4). It is observed that the divisional monsoon rainfall is maximum for Chittagong division and minimum for Rajshahi division in recent times. Analysis also shows that the linear trend lines are in decreasing trend for all divisions except Dhaka and Rajshahi. The observed data and linear trend line shows increasing trend of rate 0.0075 mm/yr for Dhaka whereas the increasing trend of Rajshahi division is negligible. The extremely decreasing trend is found for Sylhet division during last decades (1981-2010) which is about 0.4377mm/yr. But Sylhet division was the rainiest area of

Bangladesh in past days. It means the rainfall events have increased over Dhaka and decreased over Sylhet division significantly in recent times due to climate change.

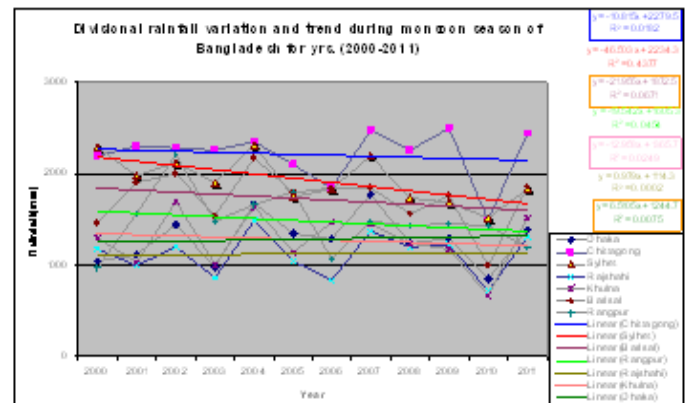


Figure 4: Divisional rain trend over Bangladesh during monsoon season (2000-2011)

Comparison of mean total and normal rainfall

To study the variation of rainfall we also made comparison of mean total and normal rainfall over Bangladesh. We compared and analyzed only the monsoon rain during the recent years (Figure 5).

We have found from observation that the mean total rainfalls are more than normal rainfall for 2002, 2004 and 2007 whereas less than normal one for 2010 only. Both are nearly same for 2000, 2001, 2005, 2006, 2008, 2009 and 2011.

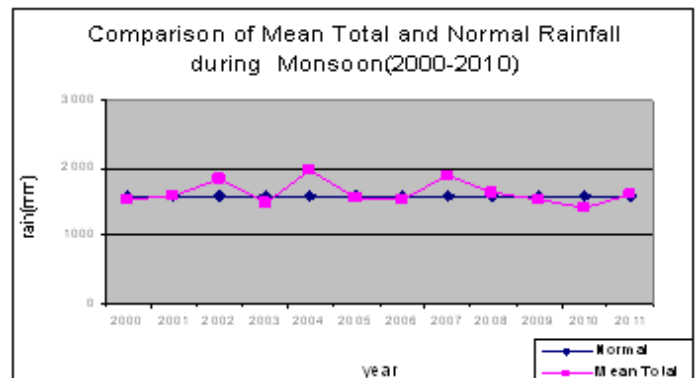


Figure 5: Comparison of mean total and normal rainfall during monsoon (2000-2011)

Due to unequal length of records, comparison of result with respect to different stations and seasons are difficult. In Bangladesh, information on data quality is very sparse. There are lots of missing data, which would affect the result related to the trend analysis substantially (Sharmeen Farhana et al, 2011).

Conclusion

Bangladesh is one of the most vulnerable countries often faced natural calamity. The country is under the threat of climate change and its impact (Yahya, et al., 2010). It is observed from this study of rainfall variation and trend over Bangladesh that the annual rainfall trend is showing an increasing trend during the period 1951-2010 whereas decreasing trend during 1981-2010 which means the annual rainfall is decreasing in recent years. Seasonal rainfall analysis for last 30 years (1981-2010) shows the maximum rainfall variation in monsoon season. It also shows decreasing trend of rainfall for all seasons except post-monsoon during this period. That means, rainfall is

decreasing in recent years due to climate change and global warming. Again, the divisional rain trend analysis shows decreasing trend for all divisions except Dhaka and Rajshahi during 2000-2011. But, at the same time, the extremely decreasing trend is found for mostly rainy division Sylhet which is found about 0.4377mm/yr. That means the rainfall events have increased over Dhaka and decreased over Sylhet division significantly during last decades. The comparison of rainfall during the last decades show that the mean total rainfall are more than normal for 2002, 2004 and 2007 whereas less than normal one for 2010 only. Thus it can be summarized that the rainfall is decreasing in recent years due to climate change and the sharp decreasing trend of rain over Sylhet division may be one cause or key for decreasing of rainfall over the whole country Bangladesh.

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