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HAS CLIMATE CHANGE ALREADY AFFECTED THE TEMPORAL TRENDS OF SEASONAL AND ANNUAL PRECIPITATION IN SYLHET DISTRICT OF BANGLADESH?

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ABSTRACT

Talucder MSA (2015) Has climate change already affected the temporal trends of seasonal and annual precipitation in Sylhet district of Bangladesh? *J. Soil Nature* 8(3), 21-27.

Understanding the variability in precipitation is an urgent issue for sustainable ecological-societal system under the projected consequences of global warming and climate change. The objective of this study was to document and examining the seasonal and annual pattern of precipitation in Sylhet districts of Bangladesh from daily precipitation data of Sylhet meteorological station for a period of over 40 years (1975-2014). Annually, 40 years average precipitation was 4060±613 mm whereas dry season, pre-monsoon, monsoon and post-monsoon season were 180±121 mm, 941±296 mm, 2695±525 mm and 245±142 mm, respectively. Consequently, dry season, pre-monsoon, monsoon and post-monsoon season on an average explained the 3%, 22%, 70% and 4% of average annual precipitation, respectively. Dry season showed the most inconsistency (coefficient of variation, C.V. 67%) while monsoon season showed the most consistency (C.V. 19%) among the season. Precipitation of this region showed slight decreasing trend by negative slope irrespective of four seasons and all timescales. It indicates that climate change has already affected the temporal trends of seasonal and annual precipitation in Sylhet district. Understanding from this research would be helpful to ameliorate economic damage caused by sudden flash flood during pre-monsoon and monsoon as well as by drought during post-monsoon and dry season through adopting suitable rain water harvesting technology.

Key words: *precipitation, climate change, temporal pattern, rain water harvesting, climate-smart water management*

INTRODUCTION

Understanding the trend of precipitation at different temporal scale is crucial for sustainable ecological-societal system under the lens of climate-smart agriculture framework (FAO 2013; Lipper *et al*. 2014). Agricultural systems mainly depend on precipitation for water supply in most of the part of the world. Crop production in Sylhet region is also highly dependent upon amount and distribution of precipitation. In addition, there is drinking water scarcity due to presence of excess (beyond 1.00 ppm) iron and low water table in this region. Furthermore, still variability of big historical precipitation data is not well understood since the characteristics of precipitation vary over spatio-temporal scale. The understanding of the characteristics of precipitation variability is important for the amelioration of drinking water scarcity as well as damage caused by flood and drought. Besides, amounts and times of rainfall are important for identifying suitable planting times of agricultural crops as well (Elnesr *et al*. 2012).

There are some studies on precipitation over Sylhet district of Bangladesh. Rahman *et al*. (2008) studied effective precipitation using four different methods for the ten meteorological stations from south-eastern part of Bangladesh and observed that as the distance from sea increases the value of effective rainfall percentage also increases. Ahsan *et al*. (2010) investigated the variability and trends of summer monsoon rainfall over Bangladesh for 50 years (1961-2010). The study also considers the investigation of the relationship of the monsoon rainfall variability with ENSO activity. The correlation analysis has also been performed between the precipitation of Bangladesh and that of Nepal and Bhutan and the nearby sub-divisional precipitation regions of India. They reported the decreasing trend of average monsoon precipitation (-0.53 mm/year) of the country as well as the eastern region (~ -2 to -7 mm/year). Choudhury *et al*. (2012) studied seasonal variations of rainfall characteristics around Sylhet using the tropical rainfall measurement mission-precipitation radar (TRMM-PR) data and Bangladesh meteorological department (BMD) Sylhet station data for recent 14 years from 1998 to 2011. It showed that the pre-monsoon precipitation contributed the year-to-year variation of the annual precipitation in Sylhet as much as the monsoon precipitation. Hasan *et al*. (2012) checked monthly average rainfall from daily records of 50 years (1957-2006) for Sylhet region using the Fast Fourier Transform (FFT) and found that almost every year there was a peak precipitation event which occurred earlier in a year compared to the previous year. Roy (2013) checked annual average precipitation of 30 years (1979-2008) in Sylhet region and found the decreasing trend of monsoon average precipitation. Hasan *et al*. (2014) examined the precipitation patterns and their associated changes in Sylhet through statistical analysis of daily precipitation data during the period of 1957-2006. It has been observed that a good correlation exists between the monthly mean and daily maximum precipitation. A linear regression analysis of the data is found to be significant for all the months. Some key statistical parameters like the mean values of coefficient of variability, relative variability and percentage inter-annual variability have been studied and found to be at variance. Shah and Hasan (2014) analyzed monthly, yearly and seasonal variations of dry days and associated changes from daily records of 54 years (1957-2010) for Sylhet region using the FFT. They found almost every year there was a peak dry event and the major dry events was slightly earlier in a year compared to the previous year. Rahman *et al*. (2015) studied the annual patterns of precipitation during 1957-2012 in Sylhet district using the non-parametric Mann-Kendal test and found no significant trend of rainfall. However, the above studies are not up-to-date and mostly concentrated on annual trend and are subject to further confirmation through more detail study by analyzing at seasonal scale. Therefore, the present study focuses on the temporal (inter-seasonal and inter-annual) variability and trends of precipitation in more details in Sylhet district by using up-to date data sets covering the 40 years (1975-2014). The analysis will improve the general understanding of the seasonal and annual precipitation variability and trends over Sylhet.

MATERIALS AND METHODS

Study site

Sylhet sadar (24.90 N, 91.88 E, 33.53 m above m.s.l) under the North-East Hydrological Region of Bangladesh (WARPO 2001) were selected for this study (Fig. 1). This region is an interesting study area because of its diversified terrestrial and wetland ecosystem. Geologically, the region is complex having diverse sacrificial geomorphology; high topography of Plio-Miocene such as Khasi and Jaintia hills and small hillocks along the border. At the centre there is a vast low laying flood plain of recent origin with saucer shaped depressions, locally called Haors. Northern branch of river Barak (comes from India) gets the name the Surma which is one of the main rivers of Bangladesh passed through Sylhet city. Southern branch of Barak gets the name Kushiara in Bangladesh, which is another major river of Sylhet. The Surma and the Kushiara make unification as Kalani, which is renamed as the Meghna and finally merges in the Bay of Bengal.

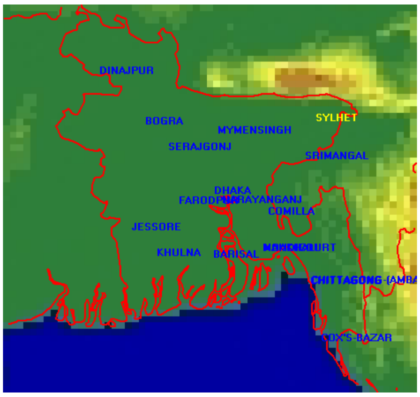

Fig. 1. Site location

Meteorological data collection

Daily precipitation (mm) of Sylhet sadar for a period of 40 years (1975–2014) was collected from the Bangladesh Meteorological Department (BMD). BMD follows the World Meteorological Organization (WMO) regulations for quality control of data. From the meteorological point of view, there are four climatic seasons in Bangladesh. They are: Dry (December-March), Pre-monsoon (April-May), Monsoon (June-September) and Post-monsoon (October-November). It may be noted here that for the computation of seasonal values for the dry season, the data of December for one year has been used with the data of January, February and March of the following year to represent the dry season value of the following year.

Statistical analysis

The 40-year precipitation record was divided into three groups such as I. Long term (20-years), II. Middle term (10-years) and III. Short term (5-years). Group I was divided into two periods of 20 years each (1975-1994 and 1995-2014). Group II was divided into four periods of 10 years each (1975-1984, 1985-1994, 1995-2004, and 2005-2014). Finally, group III was divided into eight periods of 5 years each (1975-1979, 1980-1984, 1985-1989, 1990-1994, 1995-1999, 2000-2004, 2005-2009, and 2010-2014). Seasonal and annual mean, standard deviation and coefficient of variation were calculated from each group along with linear trend from the slope of the regression line from each of them. The normal was defined as the average for the period from 1975 to 2014 in this paper.

RESULTS AND DISCUSSION

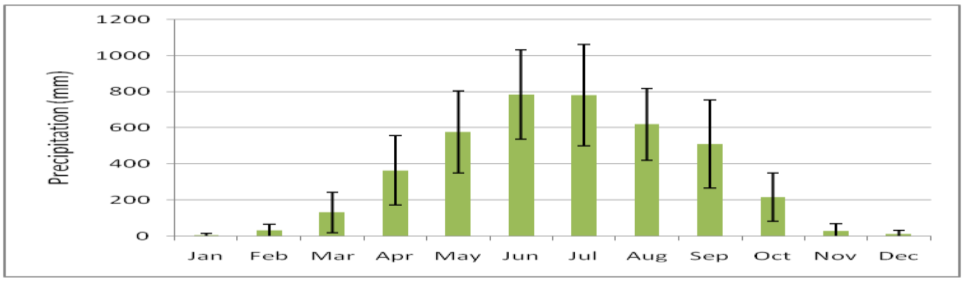

Fig. 1. Monthly mean with standard deviation from the periods of 40 years (1975-2014)

Precipitation provides natural source of water for agricultural ecosystem in Sylhet region. Annual profile of the Sylhet station mean monthly precipitation of Bangladesh shows a unimodal pattern with high precipitationin monsoon season with highest in June-July and low precipitation between November-February with lowest in January (Figure 1). Similar findings were reported by Ahsan *et al*. (2010).

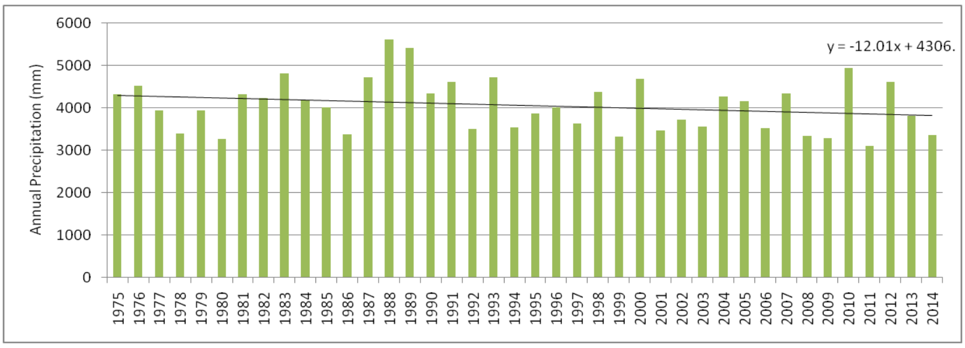

Fig. 2. Annual precipitation variability and trend during the period of 1975-2014

Figure 2 shows the annual precipitation variations of Sylhet for the period of 40 years (1975-2014). Annual normal, standard deviation and coefficient of variation were 4059.8 mm, 613.1 mm and 15.1%, respectively from 40 years period (1975-2014). It indicates that the 19 years annual precipitation was above the normal (i.e. 4059.8 mm) while 21 years annual precipitation was below the normal. Among the study period time series, annual precipitation of 1988 (5620 mm) was highest while 2011 annual precipitation (3101 mm) was lowest. The years 1988 and 1989 were very wet (>5400 mm) where 1978, 1980, 1986, 1999, 2008, 2009, 2011 and 2014 were comparatively dry years (<3400 mm).

Fig. 3. Dry season (December-March) precipitation variability and trend during 1975-2014 at (a) annual, (b) 20 years, (c) 10 years and (d) 5 years time scale

Figure 3 shows the dry season (December-March) precipitation variation and trend. Mean dry season precipitation was 180±121 mm. It showed most inconsistency (C.V. 67%) among the years. The highest and lowest dry season precipitation happened in year 1994 (580 mm) and in 2013 (23 mm), respectively. That means dry seasons were almost precipitation less. This season on an average explained the 3% of average annual precipitation. Dry season precipitation showed decreasing trend at the rate of about -1.6 mm/year, -55.0 mm/20 years, -17.1 mm/10 years, -7.5 mm/5 years time scale, respectively.

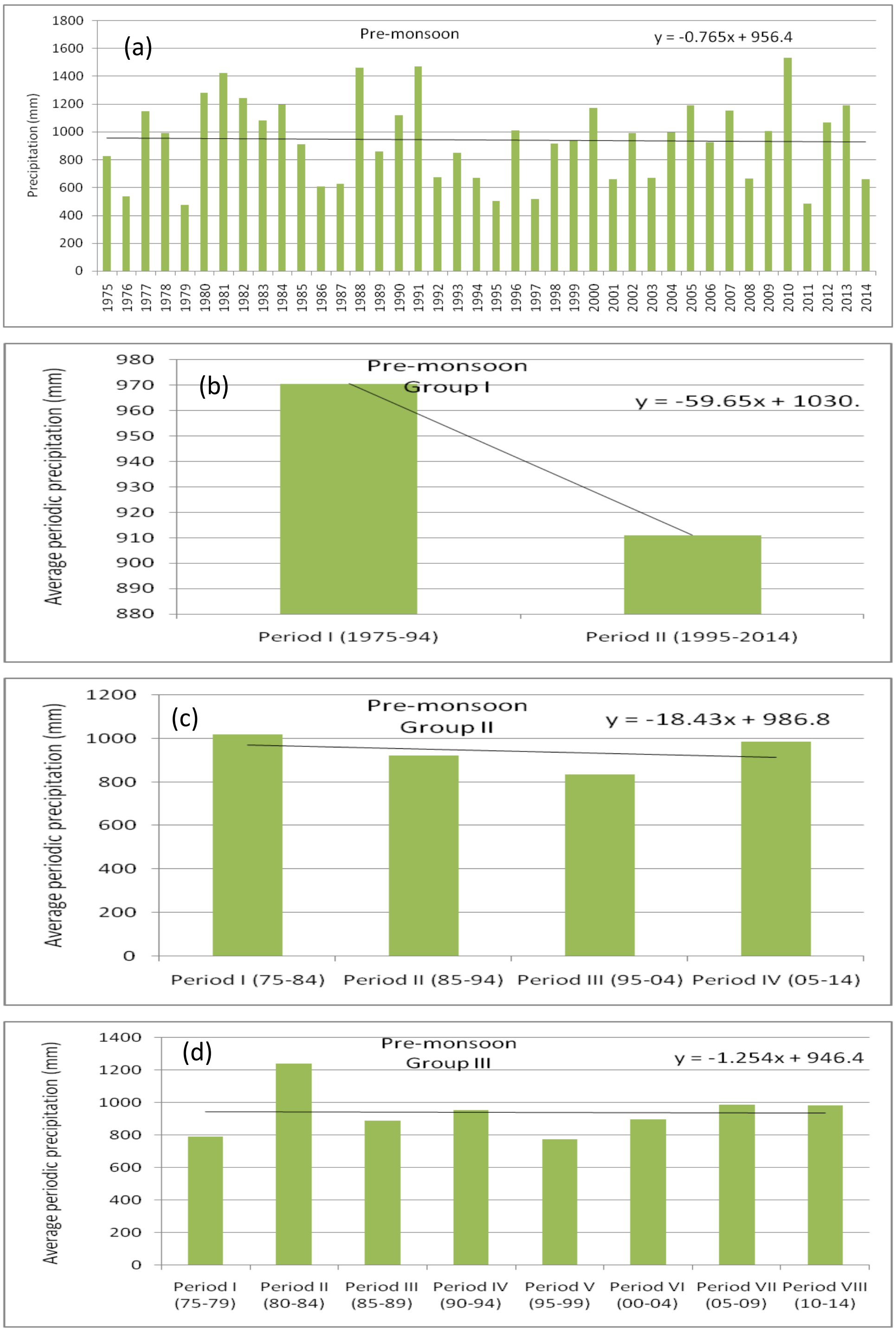

Fig. 4. Pre-monsoon season (April-May) precipitation variability and trend during 1975-2014 at (a) annual, (b) 20 years, (c) 10 years and (d) 5 years time scale

Figure 4 shows the pre-monsoon season (April-May) precipitation variation and trend. Mean dry season precipitation was 941±296 mm with a coefficient of variation was 31%. The highest and lowest pre-monsoon season precipitation was found in 2010 (1532 mm) and in 1979 (475 mm), respectively. This season on an average explained the 22% of average annual precipitation. Pre-monsoon season precipitation showed decreasing trend at the rate of about -0.8 mm/year, -59.7 mm/20 years, -18.4 mm/10 years, -1.3 mm/5 years time scale, respectively.

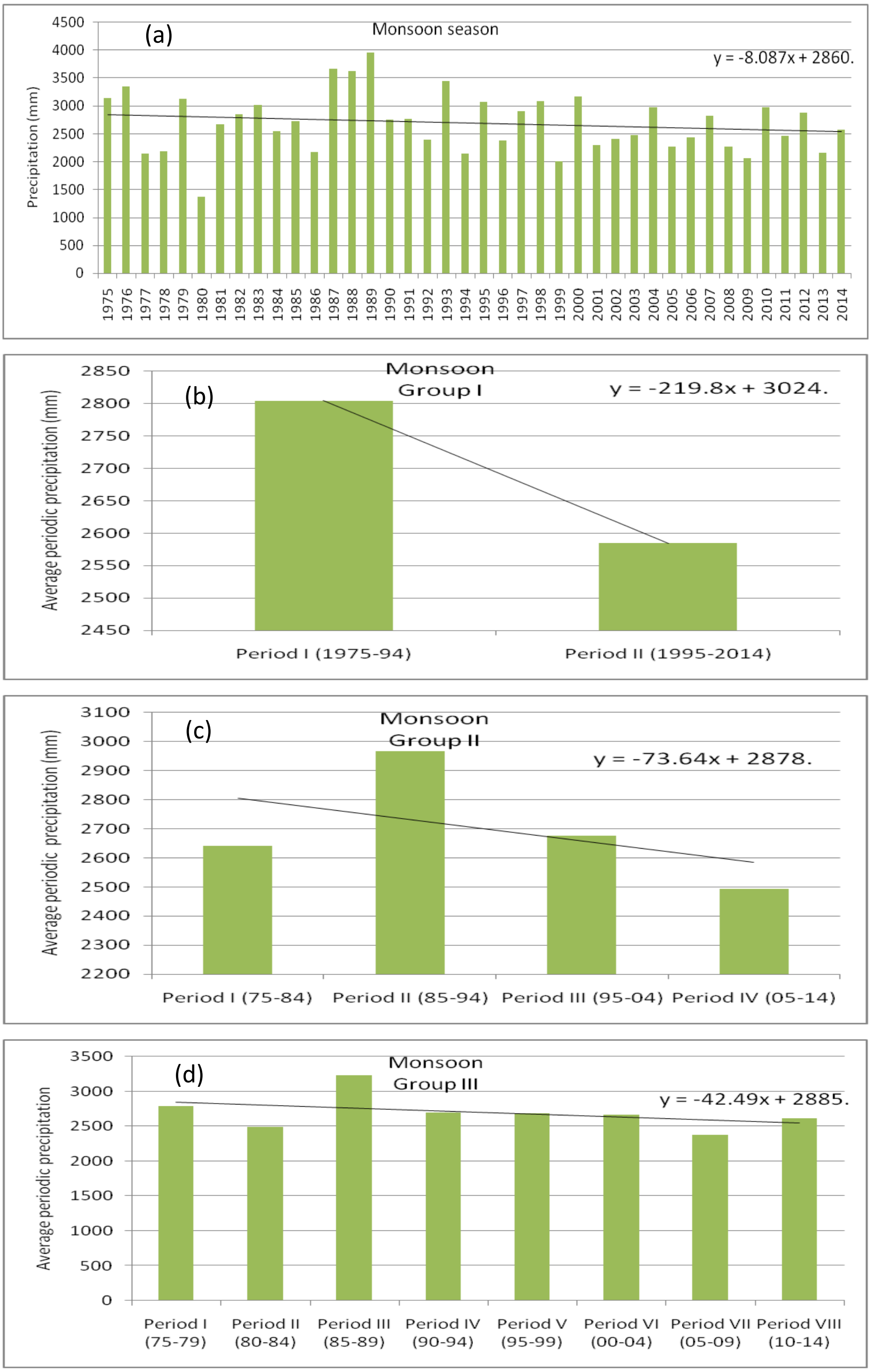

Fig. 5. Monsoon season (June-September) precipitation variability and trend during 1975-2014 at (a) annual, (b) 20 years, (c) 10 years and (d) 5 years time scale

Figure 5 shows the monsoon season (June-September) precipitation variation and trend. Mean dry season precipitation was 2695±525 mm. It showed most consistency (C.V. 19%) among the years. The highest and lowest monsoon season precipitation was found in 1989 (3958 mm) and in 1980 (1367 mm), respectively. This season on an average explained the 70% of average annual precipitation. Monsoon season precipitation also showed decreasing trend at the rate of about -8.1 mm/year, -219.8 mm/20 years, -73.6 mm/10 years, -42.5 mm/5 years time scale, respectively.

Fig. 6. Post-monsoon season (October-November) precipitation variability and trend during 1975-2014 at (a) annual, (b) 20 years, (c) 10 years and (d) 5 years time scale

Figure 6 shows the post-monsoon season (October-November) precipitation variation and trend. Mean dry season precipitation was 245±142 mm with a coefficient of variation was 58%. The highest and lowest post-monsoon season precipitation was found in 1986 (560 mm) and in 2014 (33 mm), respectively. This season on an average explained the 4% of average annual precipitation. Post-monsoon season precipitation showed decreasing trend at the rate of about -1.5 mm/year, -37.9 mm/20 years, -14.1 mm/10 years, -7.8 mm/5 years time scale, respectively.

CONCLUSION

Annually the average precipitation was 4060±613 mm from the period of 40 years (1975-2014) which supported that Sylhet is one of the heaviest precipitation areas in Bangladesh. The magnitudes of the precipitation trend were derived from the slope of the regression line. Negative slope indicated slight reducing trend of precipitation in Sylhet at all temporal scale. It is also supported by Roy (2013) and Ahsan *et al*. (2010). Since this field has still under-researched in Bangladesh, further comprehensive and appropriate research can be undertaken and implemented in this issue to produce more authentic findings for policy implications. Rain water harvesting would be a reasonable solution through the year round even distribution of water for water shortage during dry and post monsoon season and flooding problems in pre-monsoon and monsoon season. It is required that both government and non-government organizations promote the practice on a regional community and family basis.

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