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CLIMATIC NEXUS: UNDERSTANDING THE LINKAGES BETWEEN CLIMATIC VARIABILITY, RIVER WATER LEVELS, AND CROP PRODUCTIVITY TRENDS IN NORTHEASTERN BANGLADESH

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Abstract
Trend analysis serves as a pivotal tool for monitoring, forecasting, and evaluating the occurrences and values associated with specific events. Concurrently, climate change manifests as a persistent trend in climatic variables, exhibiting continuous fluctuations in average values over extended timeframes. Escalating climatic and meteorological extremes have engendered global concern due to their severe impacts on ecosystems, economies, and human livelihoods. This study explores the variability and destructiveness of these events, especially with respect to agricultural production. Notably, the likelihood of decreased cool days and nights, intensification of heavy precipitation, and prolonged droughts has surged since the 1970s. The planet is undergoing a transformative shift, marked by surges in temperature, precipitation variability, and inundation incidents. Scientific inquiries underscore an impending global temperature increase of 1.4 to 5.8 °C by 2100, accompanied by an average sea level rise of 10 cm during the same period. This analysis delves into the intersection of trend analysis and climate change, aiming to enhance our understanding of their intricate dynamics and implications.

Keywords: Trend analysis, climate change, extreme events, variability, agriculture.

1. Introduction

Trend analysis is most generally used to monitor, forecasting and assess the ratios of occurrences and or values associated with a particular event. On the other hand, climate change can be defined as a trend in one or further climatic variables characterized by an almost smooth continuous increase or decline of the average value during the long-term period of record. Outrageous climatic and weather events in recent decades have been a fundamental worldwide issue due to the brutality of the effects on natural climates, the economy, and human existence (Suryabhagavan, 2013; Wang and Qin, 2017; Plisnier et al., 2018). These outrageous occasions are variable and destructive, particularly on agriculture production. The probability of modest cool days and nights, extending heavy precipitation events, and droughts have increased since the 1970s (Sun et al., 2016). The worldwide environment is encountering a significant change shown by rising temperature, droughts, rainfalls, and flooding. Scientific

investigations showed that the mean worldwide temperature could rise by 1.4 to 5.8 °C in 2100 with a mean water level ascent of 10 cm over a comparable period as announced by the Intergovernmental Panel for global environmental change in 2008
(Roth et al., 2018). In any case, significant provincial and occasional changes inside the environment are expected, influencing climatic factors relying upon the areas with incredible effects on conditions and human frameworks (Chen and Grasby, 2014). The recent extending frequency of heavy rain and severe droughts in multiple parts of the globe is a sign of those situations.

Agriculture is typically vulnerable to cold climate conditions and environmental conditions. Despite technological advances like amended crop varieties and irrigation systems, weather and climate are important factors, which play a significant role in agricultural productivity. Bangladesh includes an enormous agricultural base with 76% of the all-out populace living in rural regions and 90% of the agricultural population identified with cultivating. Adding food creation and accomplishing food security in Bangladesh requires sustainable development of the agricultural sector. The Agro-Economic beneficence is 20.83 percent of the Gross Domestic Product (Bangladesh Economics Review, 2009). Rice and wheat are the principal sources of food, calorie, and protein admission for large numbers of individuals of the country (Karim et al., 2010). Bangladesh is that the 6th greatest rice maker country in the world. Within the last three to four decades, significant efforts in rice research and agricultural innovations were made to extend rice production, and it increased to about 48 million tons in 2009 from about 17 million tons in 1970 (BBS, 2009). The rate portion of rice in esteem is over 60% of the whole yield farming (Asaduzzaman et al., 2010). Wheat is the second most significant staple food crop in Bangladesh after rice. Wheat creation has improved consistently from around 0.115 million tons in 1971-72 and continuously declined to 0.73 million tons in 2005-06 (BBS, 2006).

The relationship between climate and yield is commonly harvest and region-specific (Wang, and Qin, 2017; Islam et al., 2021a). Wheat and maize are viewed as more impacted because of global climate change, considerably less on rice. 1-20 °C local rise influences the Wheat and Maize unfavorably, for Rice impacts are more noticeable at higher temp ascent of 3-50 °C. Anticipated Wheat yield might fall by 26% on the regular constantly 2100. Typical Boro rice yield may plunge by 12%. For Aman rice, the yield might diminish in 2050 yet stay unaltered during an extended term, 2100. Rice being a water-intensive crop, its efficiency is generally connected with water accessibility yet, in addition, sensitive to temperature ascending during the blooming time frame.

Consequently, a better comprehension of the environment has significant allegations for the economy and society of Bangladesh. In this review, we have attempted to make a consistently speeding up number of theoretical and experimental studies of the climate factors like temperature, relative humidity, precipitation and wind speed, cloud to evaluate their change during 1970-
2018 in Sylhet steady with the information. The present study had been undertaken to fulfill the objective to find out the changing trend of climatic parameters over the period and to explore the influences of the climatic variable on crop productivity.

2. Materials and Methods

2.1. Selection of study area

Sylhet district (Figure 1) was selected as a study area situated on the banks of the Surma River and is surrounded by the Jaintia, Khasi, and Tripura hills. The location of Sylhet city is at 24.89°N and 91.88°E, in the northeastern region of Bangladesh.

The total area of Sylhet is 3,490.40 sq.km or 1,347.65 sq.miles. This area is about 8% of the total land of Bangladesh.

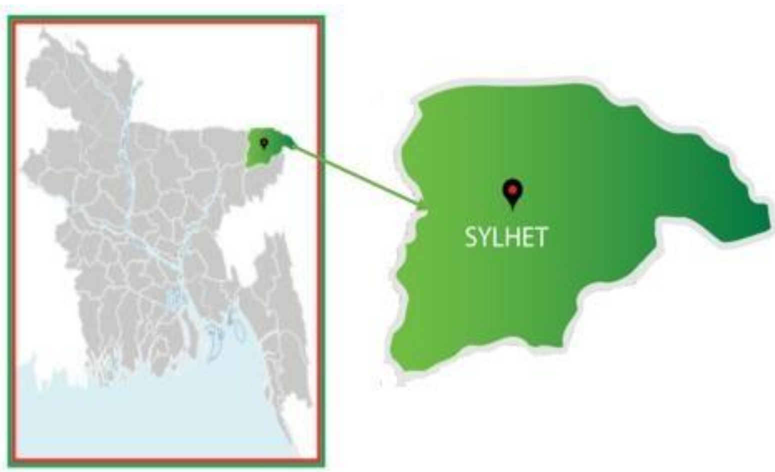

Figure 1. Map of the study area.

2.2. Climate of the study area

The climate of Sylhet is a tropical rainy season with a mainly hot and humid summer and a comparatively cool winter. The annual average maximum temperature of Sylhet is 33.20 °C, and the minimum temperature is 13.60 °C. Annual total rainfall on average is 3334 m. Sylhet's foremost and longest river is Surma (350 km); the other major rivers are Kushiyara and Piyan. The crop production of Sylhet is highly dependent on the annual water flow by the Surma River.

2.3. Climatic data (Time-series)

There is one meteorological station available in the Sylhet district. This station records the daily maximum temperature, minimum temperature, rainfall, relative humidity, wind speed, cloud cover data. These datasets were obtained from the Bangladesh Meteorological Department (BMD) for Sylhet district weather station from 1970 to 2018. Then the data was converted to average seasonal data according to the growing periods of the four crops considered in this study.

2.4. River water level data

Daily River water level data expressed in (m) of different study area stations covering major rivers were collected from the Bangladesh Water Development Board (BWDB) from 1996-2018. The different station's water level data was then accumulated to understand the overall river water level of the study area. After that, data were converted into average seasonal data based on the growing periods of the four crops.

Table 01. The average seasonal data according to the growing periods.

Crop	Cultivation Period	Frequency	Data Available
Aus Rice	From March to August	Annual	1970-2018
Amon Rice	From May to December		
Boro Rice	From November to May		
Wheat	From December to April		

2.5. Agricultural data

Data on the Aus, Aman, and Boro rice and Wheat in the period (1970–2018) were collected from the Yearbook of Agricultural Statistics of Bangladesh published by the Bangladesh Bureau of Statistics (BBS), as well as the Department of Agricultural Extension (DAE), and also from BRRI (Bangladesh Rice Research Institute). Yield data were found on the fiscal year basis, such as 1971–1972, 1972–1973, and these fiscal year data were converted into yearly data; for example, 1971–1972 was considered 1972.

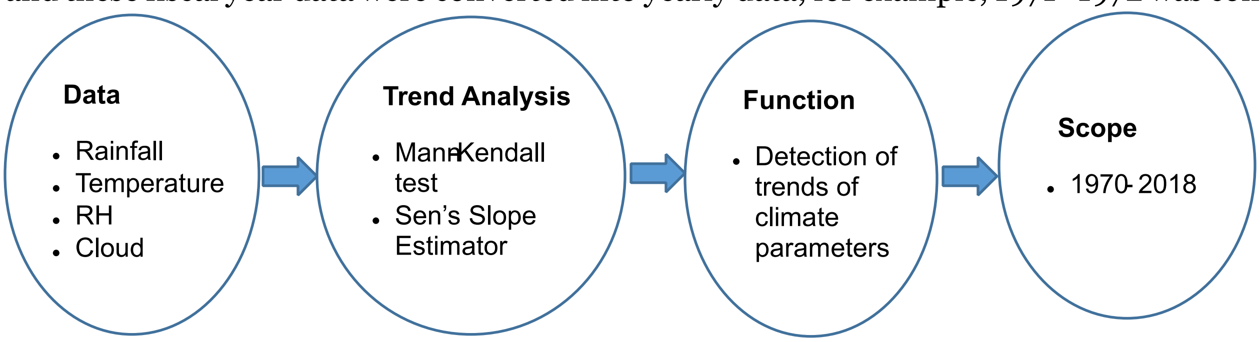

Figure 2. Flow diagram to detect trends of climatic parameters.

2.6. Data analysis

The trend analysis was performed on all available seasonal climatic, yield, and river water data to find any increasing or decreasing scenario present in any variables throughout the period. Here, the Mann-Kendal trend test was performed to analyze the data. The most popular software Statistical Package for Social Sciences (SPSS), was used to determine the climate-crop yieldriver water level relationship. This Mann-Kendall test is appropriate in cases when the data values xi of a time series can be supposed to obey the model

$$xi = f(ti) + \varepsilon i, \quad (1)$$

Where f (t) is an unceasing monotonic increasing or decreasing function of time, the residuals ε_i can be assumed from the same distribution with zero means. The variance of the distribution is constant in time. To test the null hypothesis of no trend, Ho, i.e., the observations xi is haphazardly ordered in time, against the alternate hypothesis, H1, where there is an increasing or decreasing monotonic trend.

3. Results and Discussion

Seasonal, annual trend analysis was done using the statistical tool. The parameters were crop yield, climatic variables such as maximum and minimum temperature, rainfall, relative humidity, cloud cover, wind speed, and river water level throughout the study. Analysis of crop yield, climatic variables, and river water level trends over the study period are shown below. Bangladesh is an agro-based delta island situated at the shore of the Bay of Bengal. Bangladesh is a country that is generally vulnerable to hazardous global climate change and its belongings throughout the world (Ali, 1999; Shahid, 2011; Islam and Nursey-Bawl, 2017; Vij et al., 2018). Bangladesh is in a dangerous condition because of worldwide environmental change, where numerous catastrophic events like heat, flood, cyclone, drought, saline water intrusion, sea-level rise, and heavy monsoon downpours are pretty common phenomena (Titumir and Basak, 2012; Basak et al., 2013). Because of the historic global climate change, Bangladesh's occasional cycle has changed from six seasons to three, which might be essentially described by a warm summer, a contracting winter, and medium to heavy rains during the monsoon season (Denissen, 2012). So, multi-type climatic phenomena are regularly visited alongside the whole nation, and leftovers significantly impact its current circumstance (Kuri, 2013).

3.1. Variation of crop yield over the time

The trend analysis of annual yield from 1970 to 2018 of considered crops has been analyzed using Mann-Kendal and Sen 's-slope estimation. For Aus rice, the trend shows a variation of rising and fall in the beginning and then a steady decreasing trend until 2006 (Figure 3a). After that, the trend drastically decreased and reached the lowest production of Aus rise in the year 2011. Additionally, the Z test indicates a non-statistically significant decreasing trend over the study period. The Q value shows that the slope was also decreasing at -1100.75 M.ton per year over the period (Table 02). For Aman rice, the trend starts with a quick rise in production and then gradually increases over the period (Figure 3b). The lowest production was recorded in 1989.

Table 02. Summary statistics of yield trend.

Year	Time Series	Variable	Test Z	Q value	Significance
1970-2018	Aus Rice	Yield	-0.92	-1100.75	
	Aman Rice	Yield	6.87	11028.56	***
	Boro Rice	Yield	7.16	22691.33	***
	Wheat	Yield	0.00	0.000	

Note: *, ** and *** represents α at 0.05, 0.01 and 0.001 level of significance respectively.

Furthermore, the Z test indicates a positive upward trend over the study period, and the Q value indicates an increasing slope at 11028.56 M.ton per year for Aman rice that is statistically significant at a 0.001 level of significance. A similar result has been found for Boro rice (Figure 3c) that shows the lowest production was recorded in 1977. There was also a statistically significant
0.001 level upward trend and slope magnitude increasing at 22691.33 M.ton per year. However, for Wheat, it shows an excellent increasing trend at the beginning from 1970-1980 (Figure 3d). Afterward, the trend was increased before it started to fall in the year 1995. So, the Z test found no trend over the observed period and no change in slope. So, the production of Wheat was deficient as compared to rice production. The adverse consequence of climatic elements on crop yields might become articulated from around the year 2030 but become more confident by the year 2050 and thus the end of the 21st

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century. For each back-toback decade, the yield decrease is anticipated to be worldwide 1%; a little, however, non-minor part of generally 14% increase in productivity needed to stay up with rising demand (Asaduzzaman and Anik, 2017). The low (10/5 °C, day/night), medium (20/15 °C, day/night), and high (30/25 °C, day/night) day-night temperature affects the yield of wheatgrass (Islam et al., 2021b).

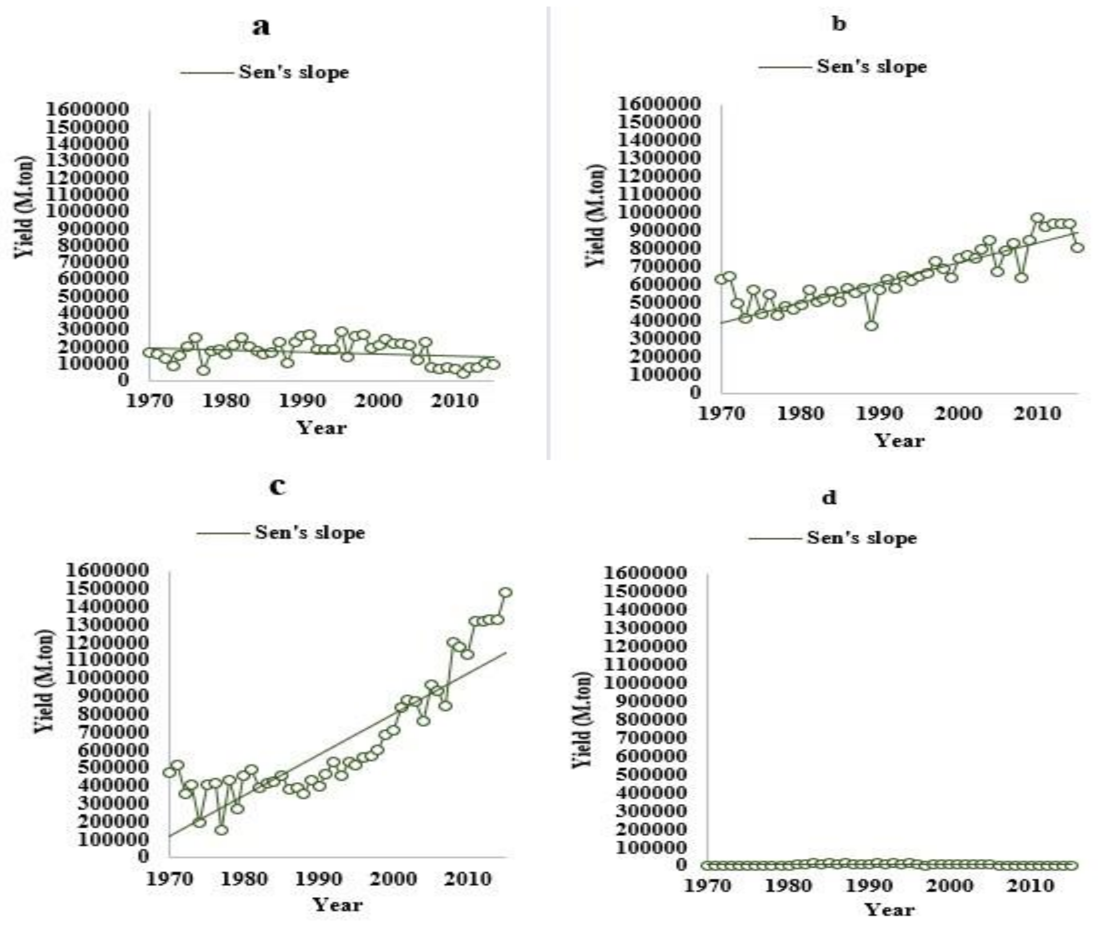

Figure 3. Production of (a) Aus, (b) Aman, (c) Boro and (d) Wheat, Sylhet, Bangladesh (1970-2018).

3.2. Variation of temperature over the time

The Aus growing period shows a fluctuation, and the highest temperature was observed during 2014 while the lowest was in 1977 (Figure 4a). During Aman growing period, the maximum temperature shows a similar fluctuating line with the highest temperature was found in 2014, and the lowest maximum temperature was in 1974 (Figure 4b). During the Boro growing period, the maximum temperature trend shows a sudden drop in 1971 and a sudden increase in 1979 and 1999 (Figure 4c). After that, a gradual rise was found and continued afterward. For a Wheat-growing period, a similar rise and fall exhibit the maximum value found in 1999 and the minimum value in 1971 (Figure 4d). The Man-Kendall test Z provides a similar statistically significant at 0.001 level of significance upward trend throughout 1970 to 2018 (Table 03). Q test also gives a positive increasing slope magnitude over the observed period for all four-crop growing seasons.

Moreover, the minimum temperature of four crop growing seasons is similar to the maximum temperature (Figure 5a-d). The Man-Kendall test Z and Sen's Slope Test Q provide a statistically significant upward trend at 0.001 level of significance over the detected period (Table 03). During the Aus growing period, the trend shows a slight increase and then a steady increase until a drastic fall was found between 1983 and 1987 (Figure 5a). After that, the minimum temperature trend shows a steady increase over the period. A similar result was found in the Aman growing period, as shown in the graph (Figure 5b). In the Aus growing season, the maximum and minimum temperature was increased at 0.05 °C and 0.02 °C per year. A similar increase in temperature was found in the other three crop growing seasons. Although both the minimum and maximum temperature increased and the rate of the maximum temperature for the Aman growing period was faster than that of any other maximum temperature. Also, for Boro and Wheat season, the minimum temperature was lower than the other two seasons.

Table 03. Summary statistics of the temperature trend.

Year	Time Series	Variable	Test Z	Q value	Significance
1970-2018	Temperature/Aus	Maximum Temperature	5.62	0.05	***
		Minimum Temperature	4.61	0.02	***
	Temperature/Amon	Maximum Temperature	7.06	0.04	***
		Minimum Temperature	5.09	0.02	***
	Temperature/Boro	Maximum Temperature	5.26	0.04	***
		Minimum Temperature	5.30	0.04	***
	Temperature /Wheat	Maximum Temperature	4.43	0.04	***
		Minimum Temperature	5.17	0.04	***

Note: *, ** and *** represents α at 0.05, 0.01 and 0.001 level of significance respectively.

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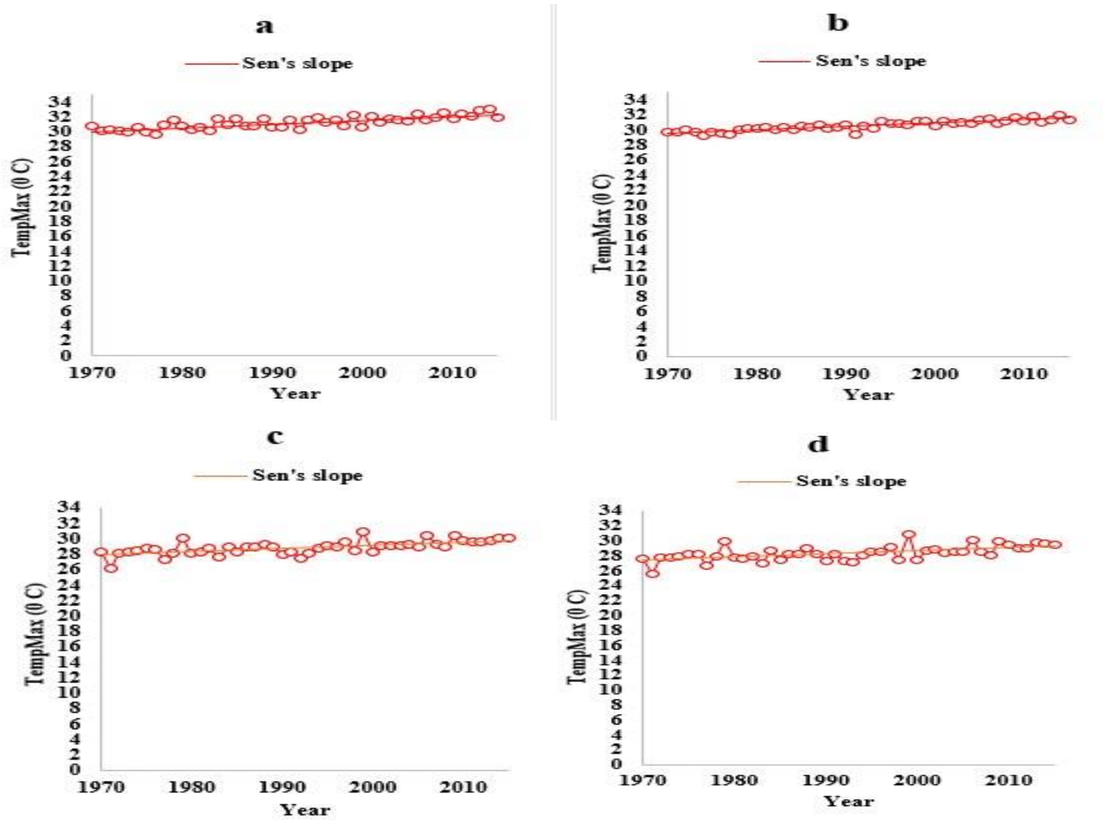

Figure 4. Variation of Maximum Temperature over the four-crop growing seasons (a) Aus, (b) Aman, (c) Boro and (d) Wheat, Sylhet, Bangladesh (1970-2018).

Moreover, most studies have highlighted the daily maximum and minimum temperature variables before the year 2008, even without considering all the records of the meteorological stations. Shahid et al. (2012) revealed that the temperature had expanded widely inside the most recent fifty years (1961-2008). Compared with the summer, the winter is warming more, and consequently, the colder time of year and pre-monsoonal diurnal temperature range in Bangladesh has diminished; however, the temperature range has expanded inside the monsoon season. In Bangladesh, low temperature, i.e., the cold problem, happens in the winter season for the most part during November to February when the base temperature frequently remains beneath 20 °C. In certain country pieces, most minor temperatures happen under 20 °C, even in March and April (BRRI, 2002). Islam et al. (2002) mentioned that rice production mainly depended on rainfall.

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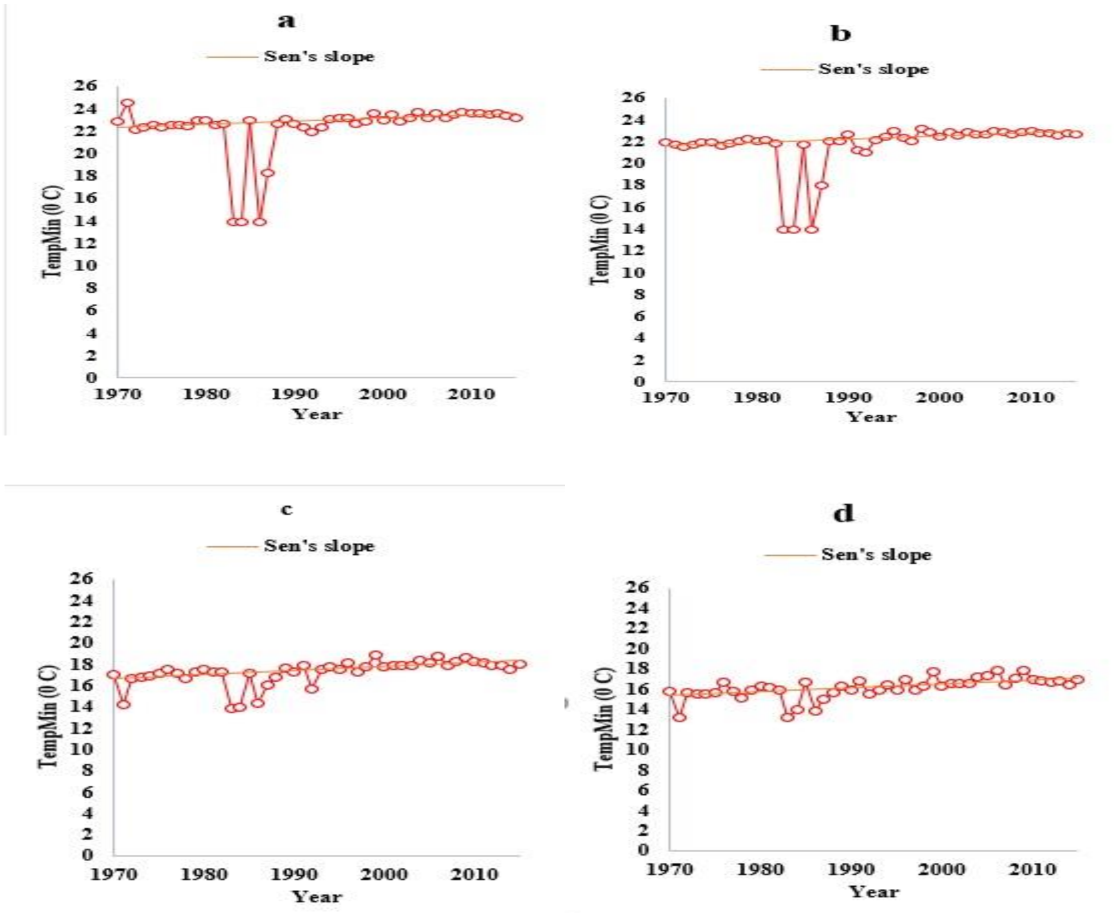

Figure 5. Fluctuation of minimum temperature over the four-crop growing seasons (a) Aus, (b) Aman, (c) Boro and (d) Wheat, Sylhet, Bangladesh (1970-2018).

3.3. Variation of rainfall over the time

The Z test's rainfall for Aus, Aman, and Wheat season showed a decreasing trend with fluctuation, but it increased (Table 04). For Aus, Aman, and Wheat season, the Q test indicates a slope of decreasing rainfall at 0.04 mm, 0.03 mm, and 0.004 mm per year, respectively, while for Boro season, the slope detects a marginal change. The test is not statistically significant for any of the crop growing seasons but Aman season. The graph (Figure 6a) shows that in the Aus season, the rainfall trend of the study area provides dramatic rise and fall over the observed period. The highest rainfall was found in the year 1988, and the lowest rainfall was recorded in 1971. However, the rainfall trend also drastically rises and falls in the Aman growing period (Figure 6b). From 1986 to 1989 it has a quickly increasing trend then started to increase steadily with fluctuation. The Boro growing period (Figure 6c) and Wheat growing period (Figure 6d) both provides an increase and decrease trend over the period. The highest rainfall recorded for both periods was in 1971 and 1998. The lowest rainfall was found in 1971 and 1979, respectively. Finally, rainfall was lower during Boro and Wheat seasons than Aus and Aman seasons.

Deficit rainfall in Bangladesh caused drought in the rainfed ecosystem, and consequently, loss of crop yield occurs, and sometimes it becomes above the damage from a flood. Also, Sylhet highlights a specific climate that recognizes it from adjoining regions and introduces unique challenges to coping with climate variability and long-term change. The area is genuinely defenseless river floods, flash floods, intensive rainfall, and landslide. It is probably the wettest locale in Bangladesh, with an average yearly precipitation of 4080 mm (1980–2009). However, this amount can shift enormously from one year to another. Yearly precipitation absolute fluctuated between 3280 mm (1980) and 5620 mm (1988), somewhere in the range of 1980 and 2009 (Haque et al., 2017). A study in 2015 (Stiller-Reeve et al., 2015) found that the summer period is crucial between April and June. Between 1980 and 2009, the whole rainfall in May varied between 222 mm (1987) and 1129 (1988). With the rains come regular flooding, with both positive and adverse consequences.

Table 04. Summary statistics of rainfall trend.

Year	**Time Series**	**Variable**	**Test Z**	**Q value**	**Significance**
1970-2018	Rainfall/Aus	Rainfall	-1.10	-0.04	
	Rainfall/Aman	Rainfall	-0.93	-0.03	
	Rainfall/Boro	Rainfall	0.06	0.001	
	Rainfall/Wheat	Rainfall	-0.13	-0.004	

Note: *, ** and *** represents α at 0.05, 0.01 and 0.001 level of significance respectively.

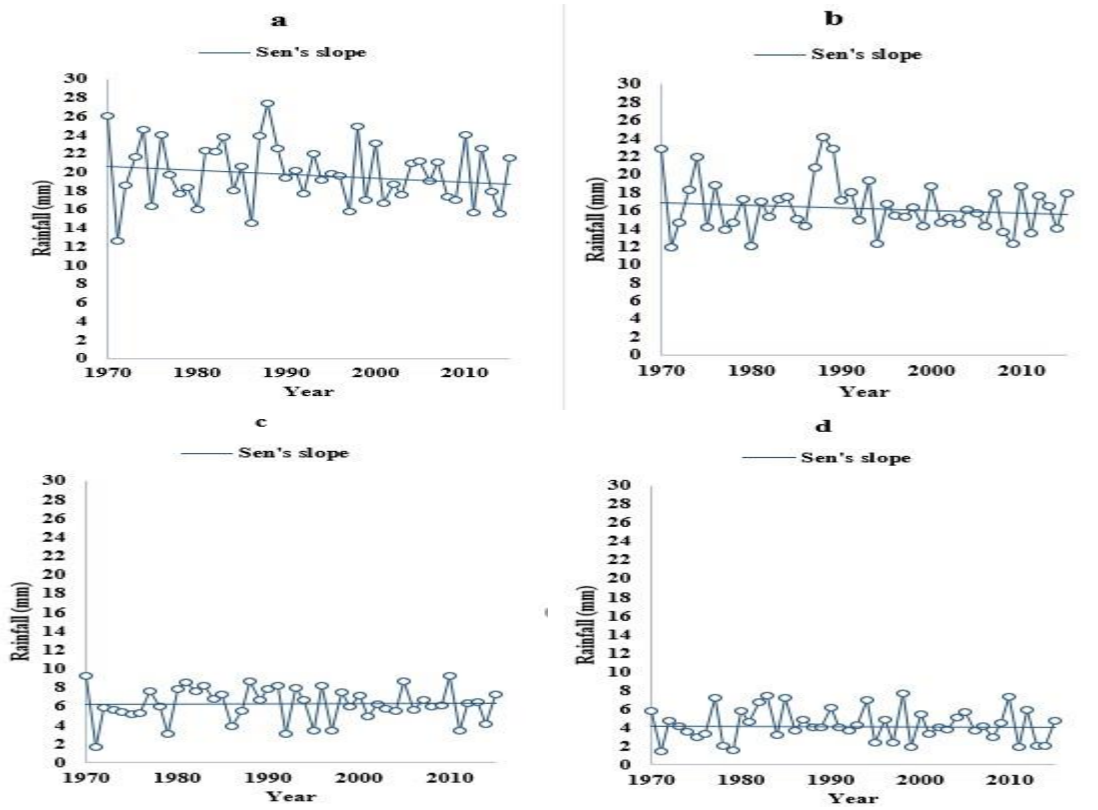

Figure 6. Rainfall variation over the four-crop growing seasons (a) Aus, (b) Aman, (c) Boro and (d) Wheat, Sylhet, Bangladesh (1970-2018).

3.4. Variation of relative humidity over the time

Relative humidity for Boro and Wheat season, the Z test shows an increasing trend, but it shows a decreasing trend (Table 05). For Boro and Wheat season, the Q test indicates an increasing slope magnitude, while for Aus and Aman season, the test provides a decreasing slope magnitude of relative humidity at a rate of 0.04% and 0.03%, respectively.

Table 05. Summary statistics of relative humidity trend.

Year	Time Series	Variable	Test Z	Q value	Significance
1970-2018	RH/Aus	Relative humidity	-2.03	-0.04	*
	RH/Aman	Relative humidity	-2.12	-0.03	*
	RH/Boro	Relative humidity	1.31	0.03	
	RH/Wheat	Relative humidity	1.46	0.06	

Note: *, ** and *** represents α at 0.05, 0.01 and 0.001 level of significance respectively.

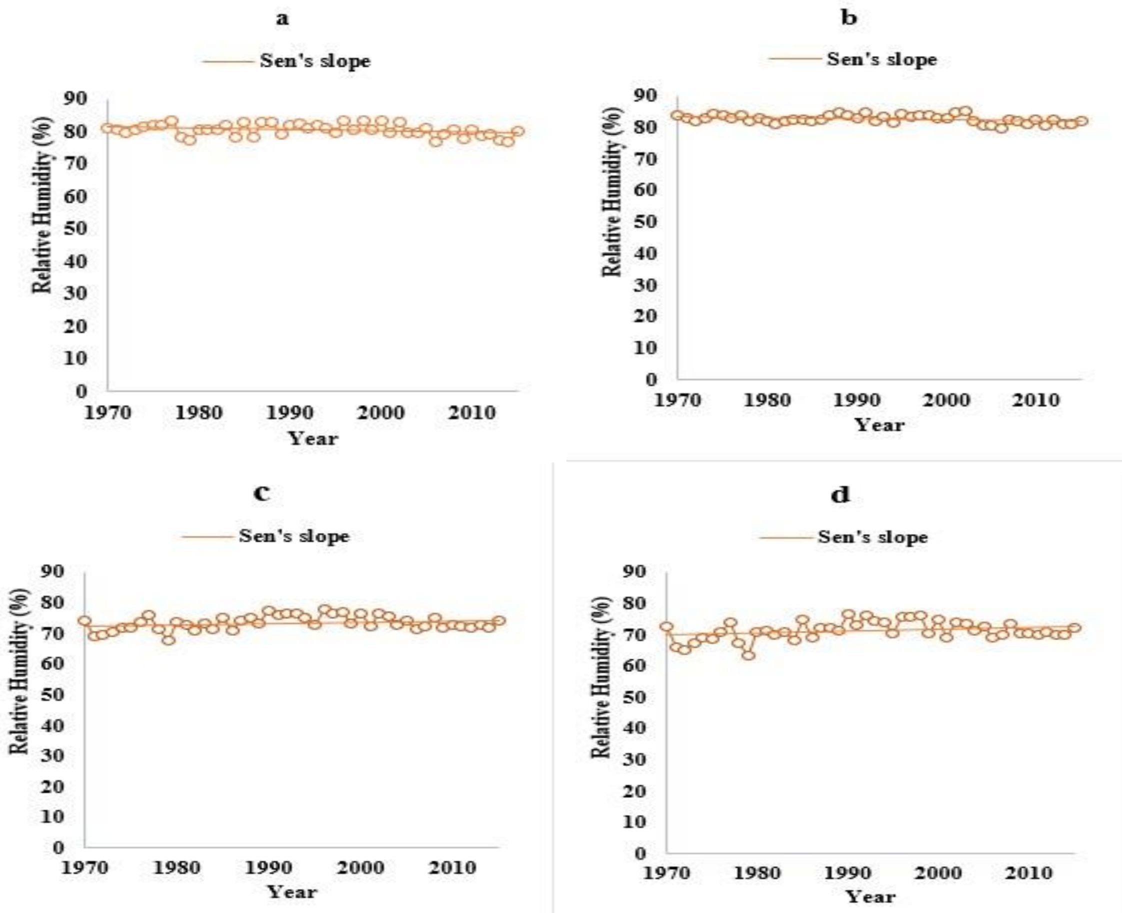

Figure 7. Variation of relative humidity over the four-crop growing seasons (a) Aus, (b) Aman, (c) Boro and (d) Wheat, Sylhet, Bangladesh (1970-2018).

The test is not statistically significant for Boro and Wheat season, but it was statistically significant at 0.05 level of significance for the Aus and Aman season. The line graph shows a rise and fall over the observed period during the Aus season, with the highest value in 1993 and the lowest in 2014 (Figure 7a). In Aman season, it shows a similar trend of relative humidity as Aus season (Figure 7b). In addition, the Boro season provides a significant increasing and decreasing relative humidity trend while the highest value was in 1990, and the lowest value falls in 1979 (Figure 7c). During Wheat season, it shows a similar but more fluctuating trend of relative humidity as Boro season (Figure 7d).

As of now, it is apparent from scientific studies that our climate has experienced an abnormal human-induced change. Different climatic boundaries like precipitation, temperature, humidity, sunshine, and so on of different areas of the earth have shown critical patterns. Humidity is a critical element of the environment. Atmospheric moisture position has a significant impact on plant growth and development. Both exceptionally low and high relative humidity might cause some actual distress significantly inward conditions because the relative humidity of the air straightforwardly influences temperature.

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3.5. Variation of cloud cover over the time

In the Aus season, an increasing trend of cloud cover with steady fluctuation was observed. The values were reasonably close enough throughout the entire observed period (Figure 8a). In the case of Aman growing season, the graph (Figure 8b) shows somewhat similar results as of Aus season. Now, during Boro season, the graph (Figure 8c) provides a steady increase in cloud cover trend until 1998, then falls in the very next year. After that, it starts to increase again gradually. Lastly, the graph (Figure 8d) provides a similar but more fluctuating trend in the Wheat season. However, the highest cloud cover was recorded in the year 1997 while the lowest was in 1999. The cloud cover was originated lower in Boro and Wheat season than Aus and Aman season. In addition, cloud cover for all crop growing seasons, the Z test shows an increasing trend with rising and fall. The Q test also indicates an increasing slope magnitude for all crop growing seasons.

Moreover, in the Aus season, cloud cover is increasing at 0.004 oktas per year. Lastly, cloud cover increases at 0.006, 0.004, and 0.007 oktas per year in Aman, Boro, and Wheat season. The test is not statistically significant for Aus, Boro, and Wheat season; nevertheless, it was statistically significant at 0.05 level of significance for Aman season.

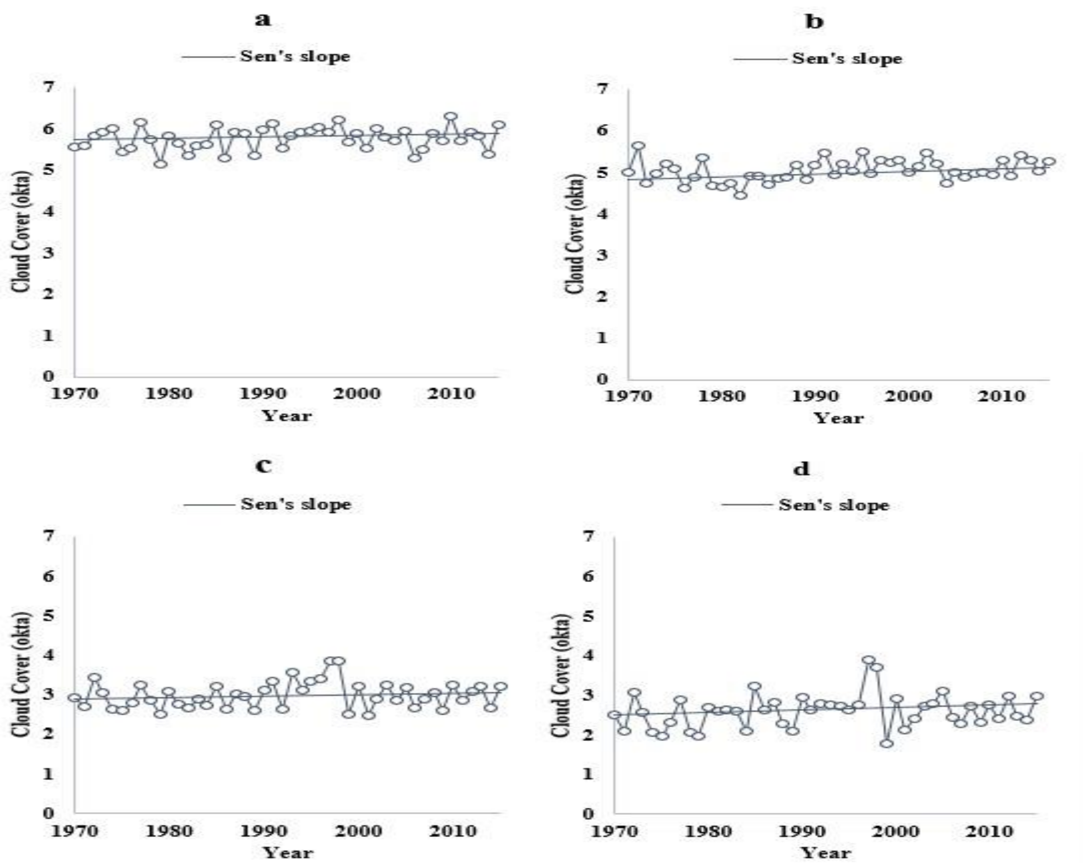


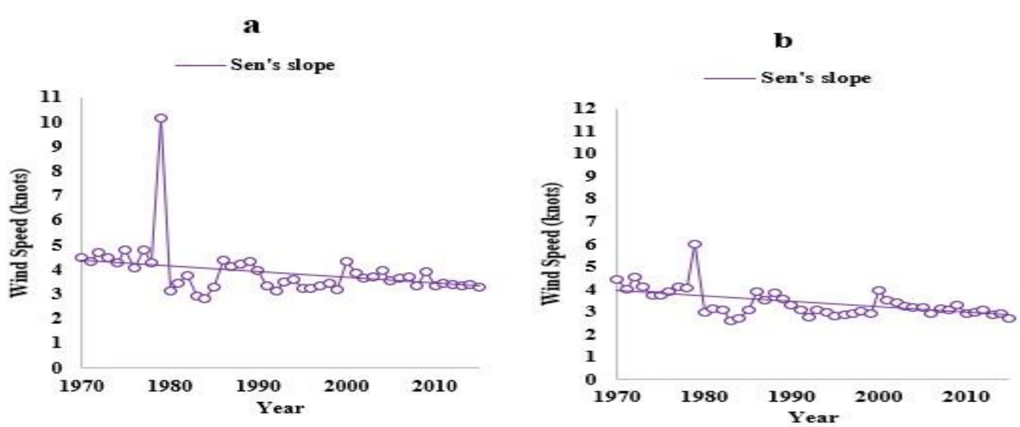
Figure 8. Variation of cloud cover over the four-crop growing seasons (a) Aus, (b) Aman, (c) Boro, and (d) Wheat, Sylhet, Bangladesh (1970-2018).

Table 06. Summary statistics of Cloud cover trend.

Year	Time Series	Variable	Test Z	Q value	Significance
1970-2018	CLC/Aus	Cloud cover	1.02	0.004	
	CLC/Aman	Cloud cover	2.20	0.006	*
	CLC/Boro	Cloud cover	0.97	0.004	
	CLC/Wheat	Cloud cover	1.63	0.007	
Note: *, ** and *** represents α at 0.05, 0.01 and 0.001 level of significance respectively.					

3.6. Variation of wind speed over the time

During Aus season, the graph (Figure 9a) shows an abnormal rise in wind speed trend in the year 1979 the drastically falls the very next year and hence continued a steady decreasing trend. Similarly, in the Aman season, the graph (Figure 9b) shows a quick rise of wind speed in 1979 then falls and carried that decreasing trend over the rest of the period. For Boro and Wheat growing season, both graphs (Figure 9c and Figure 9d) provide a rapid rise in wind speed trends between 1975 and 1979. Consequently, the Wind speed for all crop growing seasons, Z test shows a decreasing trend (Table 07). The Q test also indicates a decreasing slope magnitude for all crop growing seasons. Thus, wind speed decreases at 0.01, 0.02, 0.03, and 0.03 knots per year in Aus, Aman, Boro, and Wheat season, respectively. The test is statistically significant for Aman, Boro, and Wheat season at 0.001 level of significance. Finally, for the Aus season, the test is statistically significant at a 0.01 level of significance.



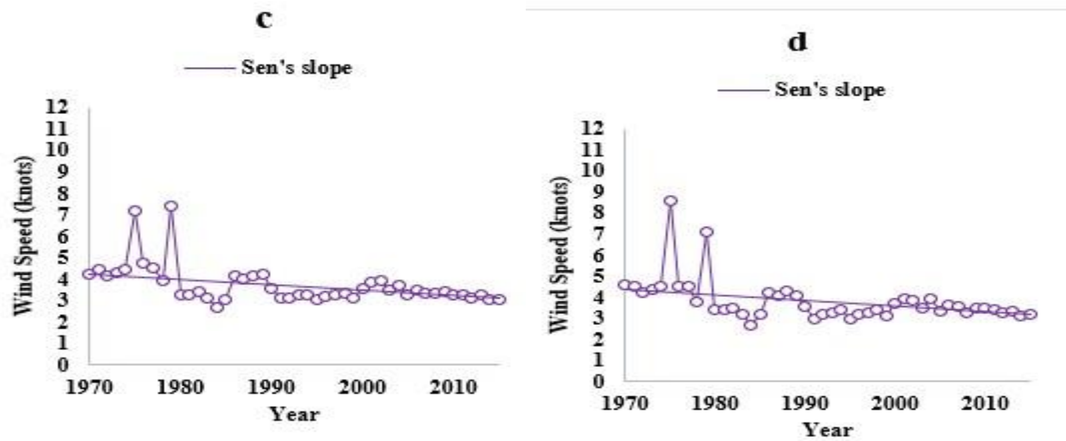


Figure 9. Variation of wind speed over the four-crop growing seasons (a) Aus, (b) Aman, (c) Boro and (d) Wheat, Sylhet, Bangladesh (1970-2018).

Table 07. Summary statistics of wind speed trend.

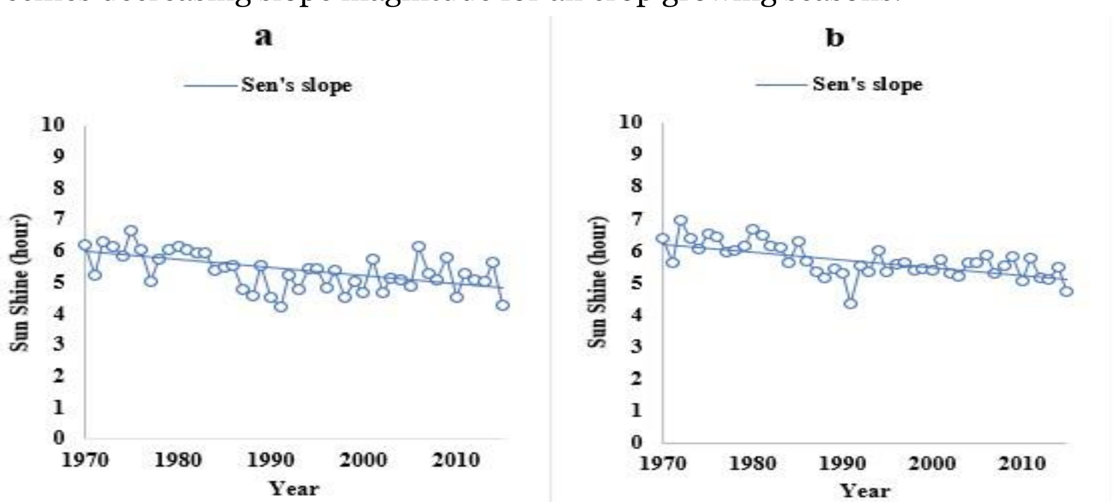
Year	Time Series	Variable	Test Z	Q value	Significance
1970-2018	WS/Aus	Wind Speed	-3.12	-0.01	**
	WS/Aman	Wind Speed	-3.98	-0.02	***
	WS/Boro	Wind Speed	-3.56	-0.03	***
	WS/Wheat	Wind Speed	-3.35	-0.03	***

Note: *, ** and *** represents α at 0.05, 0.01 and 0.001 level of significance respectively.

3.7. Variation of river water level over the time

The river water trend for all crop growing seasons, the Z test, indicates a decreasing trend with fluctuations (Table 08).

Similarly, the Q test specifies decreasing slope magnitude for all crop growing seasons.



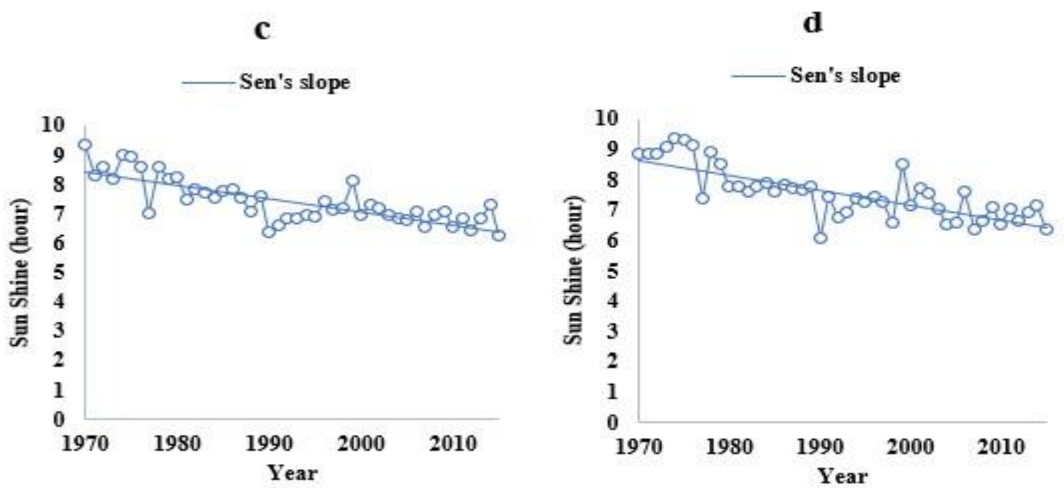


Figure 10. Variation of river water Level at the four-crop growing seasons (a) Aus, (b) Aman, (c) Boro and (d) Wheat, Sylhet, Bangladesh (1996-2018).

The average river water level for Aus, Aman, Boro, and the Wheat season declines at -0.03, -0.02, -0.005, and -0.01 m per year. Unexpectedly the test provides no statistically significant result. Hence, the graph (Figure 10a) shows a decreasing trend in the Aus season until 2009. The following year shows a quick rise of water level trend and the falls quickly. The graph (Figure 10b) shows a similar result as the Aus season in the Aman season. During, Boro season, the graph (Figure 10c) provides a lower water level with variation in the trend line. Similarly, the graph (Figure 10d) gives a lesser water level tendency over the observed period in the Wheat season.

Table 08. Summary statistics of river water level trend.

Year	Time Series	Variable	Test Z	Q value	Significance
1996-2018	WL/Aus	River Water Level	-1.20	-0.03	
	WL/Aman	River Water Level	-1.20	-0.02	
	WL/Boro	River Water Level	-0.29	-0.005	
	WL/Wheat	River Water Level	-1.14	-0.01	

Note: *, ** and *** represents α at 0.05, 0.01 and 0.001 level of significance respectively.

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4. Conclusion

Climate change is a drawn-out process. From very ancient times, the climate of the globe was continuously evolving. Climatic factors such as temperature, rainfall, relative humidity, cloud cover, wind speed, and so forth intently connect with agricultural production. The crop production would be the main issue during recent years because of changing climatic conditions. There is a lot of crop yield that might hamper just variations of those climatic parameters. The trend analysis shows a decreasing trend of Aus yield was -1100.75 M.ton per year in Sylhet, while in the Aus growing period, climatic variables such as maximum and minimum temperature, cloud cover show an increasing trend of 0.05 °C, 0.015 °C, 0.004 °C okta per year. In the case of rainfall and relative humidity, it shows a decreasing trend at -0.44 mm and -0.42% per year. In Aman season, the trend provides an excellent positive increase in yield was 11028.56 M.ton per year. The maximum and minimum temperature and cloud cover show an increasing trend was 0.05 °C, 0.02 °C, and 0.006 okta per year. Rainfall and relative humidity show a decreasing trend at a rate of -0.30 mm and -0.32% per year. Boro season provides a positive rise in yield at a rate of 22691.33 M.ton per year. The maximum, minimum temperature, rainfall, relative humidity, and cloud cover show an increasing trend was 0.04 °C, 0.04 °C, 0.001 mm, 0.033%, and 0.004 okta per year, respectively. Afterward, the Wheat season provides no positive or negative result as it was found that the yield rate was very low as compared to the other three varieties in Sylhet. Maximum, minimum temperature, relative humidity, and cloud cover show an upward trend; however, rainfall provides a declining trend at a rate of -0.004 mm per year. Though, the river water level also has a mixed trend throughout the 1996-2018 years. The study's finding is that these climatic variables significantly affected crop production, and yield might be reduced due to extreme fluctuations of climate variables in the coming future. So, necessary measures should be formulated to mitigate this phenomenon and adopt new strategies to mitigate the adverse effect of climate change on crop productivity.

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