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Research Article

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The Anomaly of Maximum Temperature in South-West Part of Bangladesh

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Abstract Bangladesh is recently experiencing climate change impact related to hazards like temperature, rainfall, flood, draught, cyclone etc. Climate variable like temperature is the most important parameter which is linked with agricultural aspects too for this country. This study investigates temporal variability of maximum temperature and anomaly on the South-West part of Bangladesh over the period of 1989- 2016. We estimated mean with standard deviation, trends and anomaly of annual maximum temperature. The annual maximum temperature is found in increasing trends in recent times. In Chuadanga and Jessore areas in the South-Western part of the country, the amount of annual average maximum temperature may be increased abruptly comparing with average normal temperature all over the country. The analysis of temperature reveals a bit different trend for the last three decades. It has been observed that the study region in which the data taken from be 3 stations have negative anomaly while 2 stations have positive anomaly. Therefore the maximum temperature is in increasing trend in recent years due to climate change over Bangladesh.

Keywords Trend, anomaly, Maximum temperature, South-West, Bangladesh

Introduction

The global climate change is one of the most significant environmental issues of the present world. Climate change presents a new type of challenge for development. In the light of recent climate trends and current predictions for the twenty-first century, climatic change is becoming a major concern for scientists and society in general. There is an increasing interest in different parts of the world in the research on extreme temperatures and their variation. Temperature extremes are an important aspect of any climate change because ecosystems and societal responses are most sensitive to them.

Temperature is one of the most important climatic parameters, and it can seriously impact the socio-economic condition of a region. Temperature is intimately related to agriculture, drought, water resources, power generation, human health, urbanization, and cold and heat-wave extremes. Rising temperature has a direct effect on crop yields as well as indirect effects on the availability of irrigation water [1]. Ultimately, the increase in temperatures in the urban climate has negative implications for energy, water consumption and human health. In the present era of global warming and climate change, understanding the exact climatic situation, especially information relating to temperature extremes, is critical. The average global surface air temperature has increased by about 0.6 ± 0.2 °C since the late nineteenth century [2], where the rate of warming in the global surface air temperature during the last half century (1956-2005) was 0.128°C/decade [3]. However, the temperature of a region varies with topographic characteristics such as high and low elevations, land coverage and land types. The last decade of the twentieth century was globally the hottest one since the beginning of worldwide temperature measurement during the nineteenth century showed that annual trends in the lowest and highest daily minimum and maximum temperatures in the latter half of the twentieth century increased at many locations throughout the world. Further global warming ranging between 1.4^0C and 5.8^0C is expected by the end of the twenty-first century, which could also lead to an increase in temperature extremes [4]. The World Bank climate change expert's opinion is that the poorest of the poor in South Asia are the most affected by climate

change. The impact of higher temperatures, more extreme weather events such as floods, cyclone, and severe drought are already being felt in South Asia and will continue to intensify [5, 6]. Climate change is recognized as the greatest long-term threat to the SAARC region [7]. Climate change presents a new type of challenge for development. It is by now widely acknowledged that climate-change impacts amplifying existing unfavorable conditions for developing countries [8]. Bangladesh is highly vulnerable as it is low-lying, located on the Bay of Bengal in the delta of the Ganges, Brahmaputra and Meghan and densely populated. Its economy strongly depends on agriculture and natural resources that are sensitive to climate change. Climate change is anticipated to aggravate the frequency and intensity of extreme weather events in Bangladesh [9]. The trend of variation of yearly average maximum temperature has been found to be increasing at a rate of 0.0186℃ per year, whereas the rate was 0.0152℃ per year for yearly average minimum temperature. Analysis of monthly average maximum temperature also showed increasing trend for all months except January and April. The increasing trend was particularly significant for May to September and February. Monthly average minimum temperature data also showed increasing trends for all months except January and November [10]. The mean temperature during the months of summer remains within 23^0C to 30^0C. April and May are the hottest months. The highest temperature ranging from 44^0C to $45\ ^0$C is attained in the Northern and North-Western districts. Over rest of the country, it ranges from 41^0C to $43\ ^0$C. The post monsoon months of October and November are the transitional months from summer to winter and it is quite hot in October. Rapid temperature changes affect the seasons causing variation in their duration. Changes like shorter winters can lead to mismatches between the key elements in an ecosystem, such as feeding periods for young birds and availability of worms or insects for their food. It also affects the growing seasons of farming [11]. In the Indian sub-continent, annual mean temperature could increase in the range between 3.5 and 5.5ºC by 2080s [12]. The present study has provided temperature trends and anomaly in South-West region of Bangladesh based on analysis of historical data of temperature recorded at 5 meteorological stations in Bangladesh. Assessments have been made, in particular, of changes in maximum temperature and anomaly of temperature pattern. Actually, this work attempts to investigate the trends of one key that is temperature. To explore these trends we examined the maximum temperature trends and also explore the anomaly.

2. Data and Methods

Data for this study have been extracted from the Bangladesh Meteorological Department (BMD). The BMD collects everyday surface data through weather stations situated all over Bangladesh. Five different stations located at different representative regions of Khulna division are selected purposively for this study. The stations are: Chuadanga, Jessore, Khulna, Satkhira and Mongla. The study period is January 1989 to December 2016. The collected data have been compiled, tabulated and analyzed by MS Excel and SPSS. Annual average and anomaly of temperature for different stations are anticipated to analyze the variation and to estimate trend line for the period 1989 to 2016. The monthly and yearly temperature data have been obtained from daily temperature data. Then, the mean and the standard deviation (SD) have been estimated from yearly temperature data.

Let us assumed that if $T_m(u_i,t)$ is the temperature at u station of *i*-th year for time t, and

$T_m(t)=\left(T_m(\mathrm{u}_1,t),T_m(\mathrm{u}_2,t),T_m(\mathrm{u}_3,t),.....,T_m(\mathrm{u}_k,t)\right)$ at point $u_1,u_2,u_3,.....,u_k$.

Therefore, the spatial mean and standard deviation for time t can be represented as

$$\bar{T}_m(t)=\frac{\sum_{i=1}^{k}T_m(u_i,t)}{k}$$

$$\sigma(t)=\left[\frac{\sum_{i=1}^{k}\left[T_m(u_i,t)-\bar{\mathrm{T}}_m(\mathrm{t})\right]^2}{k}\right]^{\frac{1}{2}}$$

$$Anomaly = \frac{T_m(u_i,t) - \bar{T}_m(t)}{\sigma(t)}$$

3. Results

The data were analyzed to investigate the variation, trend and anomaly of annual (January-December) temperature over South-West part of Bangladesh. The analysis and results of the present study on the South-West part of Bangladesh have been discussed in the subsequent sub sections.

3.1. Variation of Maximum Temperature

The annual average maximum temperature variations in study area for 5 stations data are analyzed and exhibited. The actual situations of annual average maximum temperature are shown in Figure 1. The annual average maximum temperature amount ranges between 30.90 ºC to 32.15 ºC; having standard deviation of 0.24 ºC to 0.67 ºC. Results suggest that in this region, the annual average maximum temperature was found 31.47 ºC and noted that the highest annual average maximum temperature was found 32.92 ºC (2009) in Jessore and lowest annual average maximum temperature was 30.44 ºC (1990) in Mongla. It is analyzed that the maximum temperature of the South-West region of Bangladesh is increasing except Mongla.

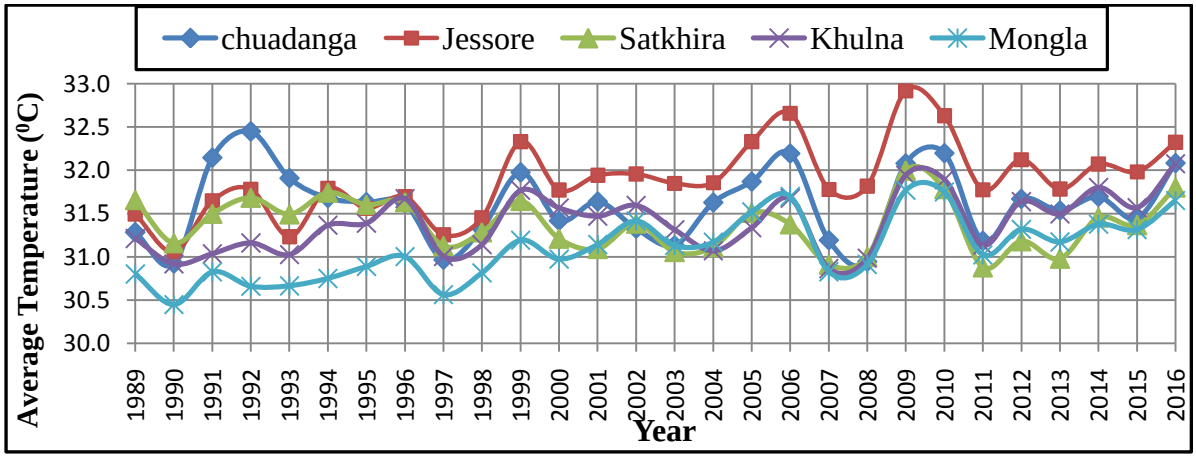

Figure 1: Annual average maximum temperature of South-West part in Bangladesh

3.2. Anomaly of Maximum Temperature

The maximum temperature anomaly has been computed for 5 stations in the study area as given in Figure 2. The analysis reveals that out of 5 stations 3 have negative anomaly while 2 stations have positive anomaly. The estimated negative anomalies of the stations were: Mongla (-1.43), Khulna (-0.30) and Satkhira (-0.85) respectively. Otherwise, the positive anomalies of the stations are shown Jessore (1.57) and Chuadanga (0.52) respectively. It is observed that the South-West region of Bangladesh showed negative anomaly except Jessore and Chuadanga.

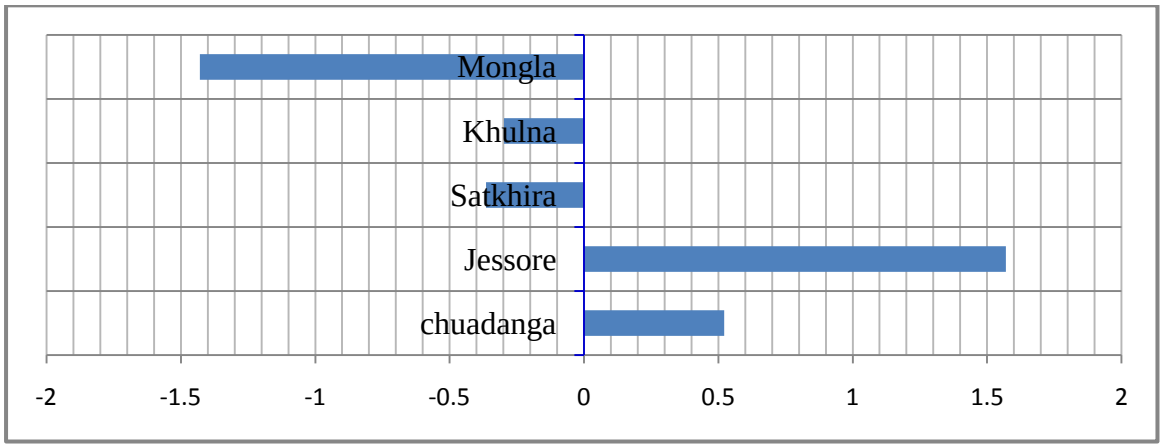

Figure 2: Anomaly of maximum temperature of South-West part in Bangladesh

4. Discussion and Conclusion

The analysis of the present study on the variability and trends of annual maximum temperature of regional has been analyzed and discussed. The annual average maximum temperature varies from 30.90 ºC to 32.15 ºC; having standard deviation of 0.24 ºC to 0.67 ºC. It also found that the average maximum temperature was 31.47 ºC. It has been observed that the trends of annual average temperature are increasing in all stations except Satkhira. The analysis reveals that the study region 3 stations have negative anomaly while 2 stations have positive anomaly. Finally, it can be concluded that the maximum temperature is in increasing trend in recent years due to climate change over Bangladesh.

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