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Change the air temperature changes at three agro-ecological zones of Bangladesh

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Abstract

Climate can be one of the biggest risk factors impacting agricultural systems performance and management. In order to managing agricultural production systems, maintain or increase economic returns and decrease environmental impacts, understanding of these changes and detailed examination of the modes of climate change at ground level and at smaller temporal and spatial scale are of crucial need. The trend of monthly maximum and minimum temperatures at three agro-ecological zones of Bangladesh: Ishurdi, Comilla and Satkhira regions were investigated to observe whether there has been any discernible change. Analyses showed the evidence of a changing pattern of both maximum and minimum temperatures at all the stations. Monthly maximum showed warming (increasing) trend at all stations, and the minimum temperature showed both cooling(decreasing) and warming trend. The study also showed that the temperature trends are not consistent throughout the year and also among stations.

Keywords: Temperature trend, Climate change, Non-parametric test, Regression analysis, Agricultural practice, Bangladesh

Introduction

Human activities such as combustion of fossil fuels and industrial and agricultural development appear to be affecting the global climate, which include possible climatic effects due to solar or terrestrial infrared radiation fields, possible changes of cloud processes and environmental effects (Ashenden and Bell, 1989). In the long run, climatic change is inevitable due to the cooling of the sun. Climatic change may show up as positive or negative trends in natural time series.

Gradual build up of greenhouse gases is bringing about changes of global climate (IPCC, 2001; Marchand *et al.* , 1988; Gleick, 1987; Droogers, 2004). Due to recent concern about global warming, hydrologists are being more inquisitive about trends and shifts in hydrologic time series. Since the inception of this century, earth's surface appears to have warmed by about 0.5 degree centigrade and the pace of warming is likely to be faster in future. Understanding these changes and projecting future changes is important in order to managing agricultural production systems (e.g. in decisions such as crop variety selection and in optimal planting times), maintain or increase economic returns and decrease environmental impacts.

Biophysical processes of agro-ecosystem are strongly affected by environmental factors. The projected increase in greenhouse gases will affect agro-ecosystems either directly or indirectly via effects on climate (e.g. temperature and rainfall). Cereals, oilseeds and pulses are mostly determinate species, and the duration on maturity depends on temperature and in many cases day-length. A temperature increase will, therefore, shorten the length of the growing period, reducing yields, if management is not altered. Irrigation water demands are particularly sensitive to changes in precipitation and temperature (Frederick and Major, 1997).

In view of concern over the potential impact of climatic variation upon agriculture, the above observations point out the need for a detailed examination of the modes of translation of hemispheric-tropospheric temperature trends to climate change at ground level and at smaller temporal and spatial scale. Therefore, to study the behavior of temperature, the main objectives of this study are to investigate the trend of monthly maximum and minimum temperatures at 3 different agro-ecological zones (AEZ) of Bangladesh.

Materials and Methods

Studied Meteorological Stations

Three different meteorological stations located at different representative regions (agro-ecological zones) of the country were selected for study. The stations were: Ishurdi ($24^0 8^{'}$ N, $89^0 3^{'}$ E, 34 m above MSL), Comilla ($23^0 20^{'}$ N, 91^0 E), and Satkhira ($22^0 44^{'}$ N, $89^0 05^{'}$ E).

Data collection

The climatic data namely, maximum temperature and minimum temperature (from 1948 to 2001) were collected from 'Bangladesh Meteorological Department'.

Trend analysis of maximum and minimum temperature

A: Non-parametric test

The trend of temperature was examined by a non-parametric test, namely " Spearman's Rho" test (Conover, 1980). The advantage of the non-parametric test is that it does not depend on absolute values of data and is equally applicable for linear and non-linear trend. This type of tests are distribution free, i.e. they do not require any assumption to be made about population following normal or any other distribution.

The test statistic ***T*** of 'Spearman's Rho' test is given by:

$$T = \sum_{i=1}^{n} [R(X_i) - R(Y_i)]^2 \quad \text{..... (1)}$$

where X_i is the value of temperature corresponding to the year Y_i, $R(X_i)$ is the rank of temperature X_i, and $R(Y_i)$ is the rank of the year Y_i. For n greater than 30, the quantiles of T is approximated by (Conover, 1980):

$$w_p \cong \frac{1}{6}n(n^2-1) + x_p \frac{1}{6}\frac{n(n^2-1)}{\sqrt{n-1}} \quad \text{.....(2)}$$

where x_p is the pth quantile of a standard normal random variable. Upper quantile was estimated from the equation:

$$w_{1-p} = \frac{1}{3}n(n^2-1) - w_p \quad \text{.....(3)}$$

In all cases, the two tailed test was done at level $\alpha = 0.05$.

B: Regression analysis

Trend was also examined by testing the significance of slope of the regression line. For this purpose, climatic variables were plotted (in y-axis) against the relative year values (year rank, e.g., for 1980 to 1997 years data, relative year values are 1 to 18). The slope of the plot represents the trend. The slope was then subjected to *t*-test for significance.

Results and Discussion

Monthly maximum temperature: The results of trend analysis of monthly maximum temperature are summarized in Table 1. From *Rho*-test, a significant increasing trend is observed during July, August, October and November at all the stations. A significant increase in June at Comilla, and in December at Ishurdi are also noticed.

Table 1. Trend of monthly maximum temperature

Type of test	Months	Stations		
		Ishurdi	Comilla	Satkhira
Rho-test (signif. at 5% level)	Jan	0	0	0
	Feb	0	0	0
	Mar	0	0	0
	April	0	0	0
	May	0	0	0
	June	0	+	0
	July	+	+	+$
	Aug	+	+	+
	Sept.	0	0	0
	Oct.	+	+	+
	Nov.	+	+	+
	Dec.	+	0	0
Regression test (sign of the slope)	Jan	–	–	–
	Feb	–	–	+
	Mar	–	–	+
	April	–	–	+
	May	–	+	–
	June	+	+*	+
	July	+	+*	+
	Aug	+*	+*	+*
	Sept.	+	+	+
	Oct.	+*	+*	+*
	Nov.	+*	+*	+*
	Dec.	+*	+	–

Note: (a) In *Rho*-test, '+', '–', and '0' imply statistically significant increasing, decreasing and no trend respectively. $ implies statistically significant in *Rho*-test, but not in regression test.

(b) In regression test, '+' and '–' imply positive (increasing), and negative (decreasing) slope, respectively. '*' indicates significant at 5 % level. ¥ implies statistically significant in regression test, but not in *Rho*-test.

Regression analysis produced similar significant (increasing) trend as that of *Rho*-test, except in July at Satkhira. The trend of maximum temperature at Ishurdi is presented in Fig.1.

Monthly minimum temperature: The results of trend analysis of monthly minimum temperature are summarized in Table 2. From *Rho*-test, a significant cooling (decreasing) trend is visible during winter (Dec.–Jan.) and also in may for Comilla. But significant increasing trend is apparent at Ishurdi (only in February) and Satkhira (in February, June and July).

Table 2. Trend of monthly minimum temperature

Type of test	Months	Stations		
		Ishurdi	Comilla	Satkhira
Rho-test (signif. at 5% level)	Jan	0	–	0
	Feb	+	0	+
	Mar	0	0	0
	April	0	0	0
	May	0	0	0
	June	0	0	+
	July	0	0	+$
	Aug	0	0	0
	Sept.	0	0	0
	Oct.	0	0	0
	Nov.	0	0	0
	Dec.	0	–	0
Regression test (sign of the slope)	Jan	+	–*	–
	Feb	+*	–	+*
	Mar	+	–	+
	April	+	–	+
	May	+	–*	+
	June	+	–	+*
	July	+	+	+
	Aug	+	+	+
	Sept.	–	–	–
	Oct.	+	–	–*¥
	Nov.	+*¥	–	–
	Dec.	+	–*	–

Notations are same as that of Table 1.

From regression analysis, similar significant trend is observed. In addition, significant increasing trend in November at Ishurdi, and significant decreasing trend in October at Satkhira are also noticed. The trend of minimum temperature at Ishurdi is presented in Fig.2.

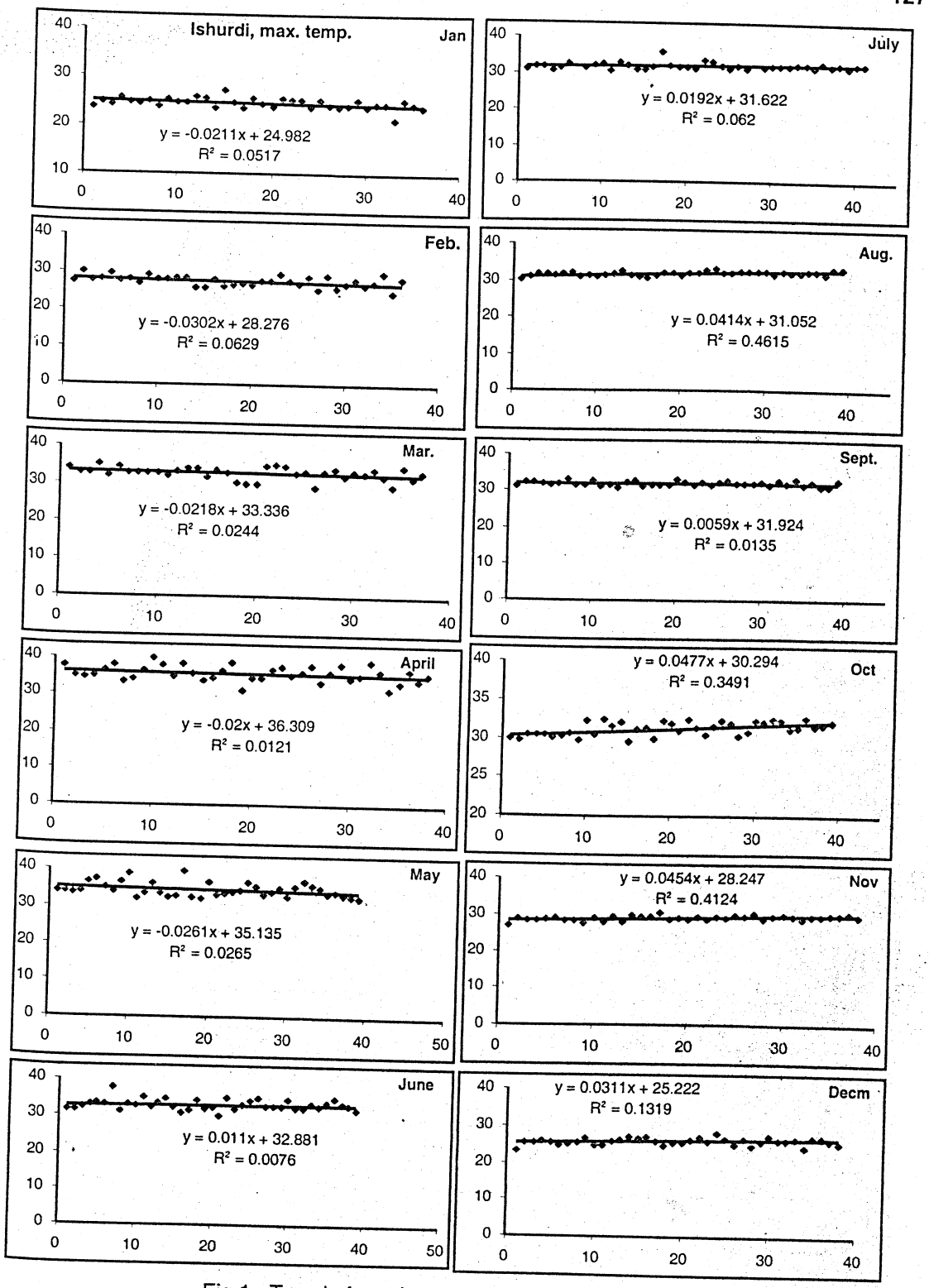

Fig.1. Trend of maximum temperature at Ishurdi

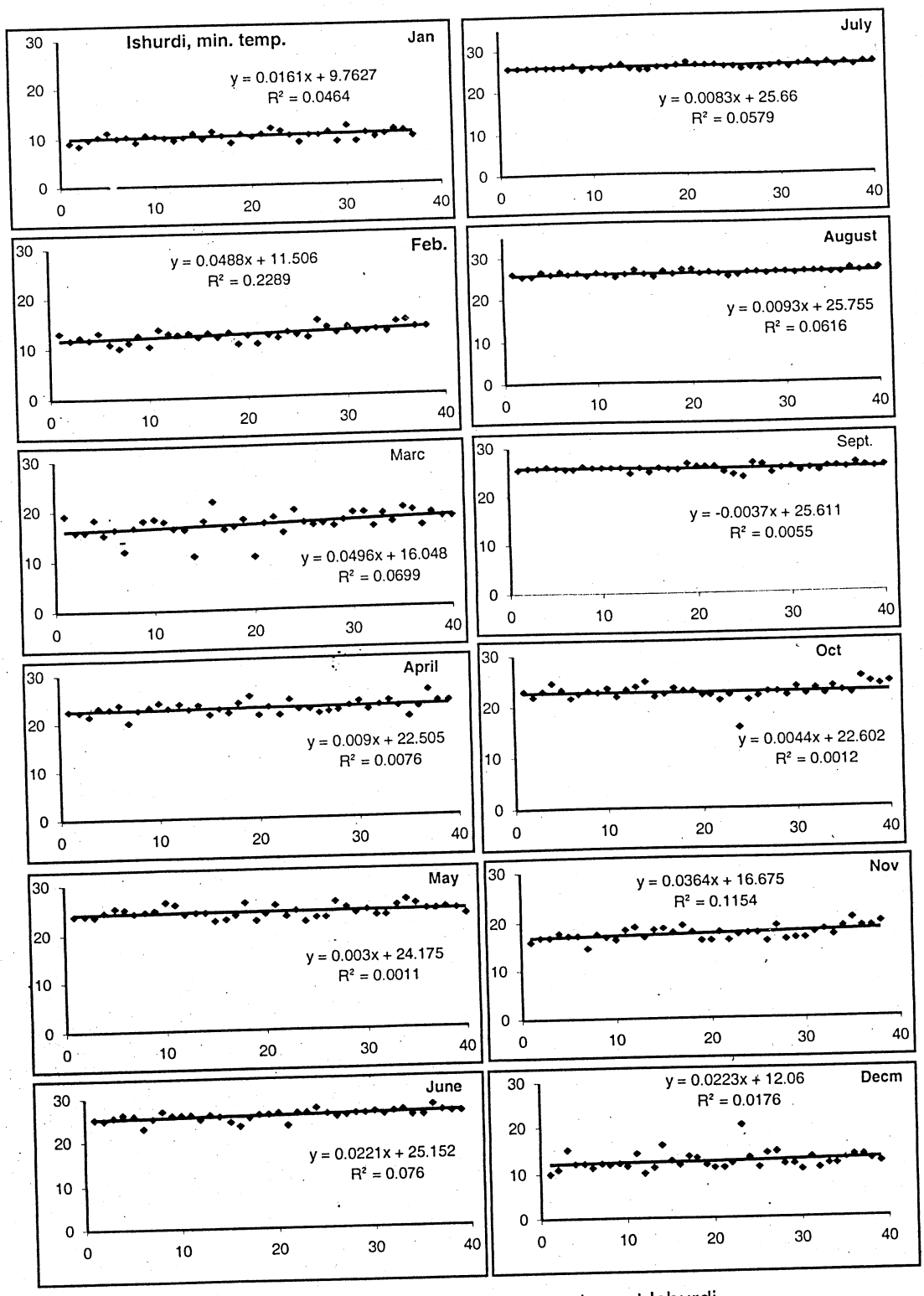

Fig.2. Trend of minimum temperature at Ishurdi

Conclusion

Non-parametric test (*Rho*-test) and regression analysis (slope test) showed similar significant trend with few exceptions. The results of the investigation show the evidence of a changing pattern of both monthly maximum and minimum temperatures (significant trend), which can be regarded as 'signature' of climate change.

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