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Temporal Trend Analysis of Temperature in Pendra of Chhattisgarh State, India

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ABSTRACT

Pendra is one of the sensitive regions to temperature variation. In this study, trends in maximum and minimum temperature at annual and seasonal time scales for the period of 1904-2013 (110 years) were examined for the Pendra, Chhattisgarh state, India. Linear regression techniques were used to determine temperature trend and its level of significance was assessed by the Non-parametric test, Mann-Kendall test. The results showed that there is positive statistically significant trend of maximum temperature (maxT) at 1% level in the study area on annual and seasonal basis. Minimum temperature (minT) data showed increase annually and seasonally even though results are not statistically significant during summer season. Maximum and minimum temperature showing increasing trend at 1 % level of statistically significant and rate of change is 0.014°C and 0.004°C/yr on annual basis.

Key words *Climate, Variation, crop, Trends, temperature, temporal*

Climate of the Earth varies across temporal and spatial scales throughout the planet. Large areas of the earth represent variability as a part of their normal climate over both short and long time periods (Houghton *et al.*, 1994; Gardner *et al.*, 1996). Climatic variability can be described as the annual difference in values of specific climatic variables within averaging period such as a 30-year period (Melillo *et al.*, 1990). These climatic variations will have unexpected consequences with respect to frequency and intensity of precipitation and temperature variability for many regions of the Earth. Air temperature is principle element of weather systems, so that examination of its behavior is important for understanding of climate variability because it is highly variable spatially and temporarily at different local, regional and global scales. For the prediction of future climate conditions, level of variability of this weather element must be examined and understood. Therefore, recently, the focus on climate variability bases mostly on the detection of trends in instrumental records of temperature. Several researches of climatic trends have recently been conducted on rainfall and temperature data at different periods of records throughout the world.

Study Area

Chhattisgarh is a comparatively new Indian state carved out of the state Madhya Pradesh in year 2000. The state is located in the central part of India, between the latitudes of 17° 46' N - 24° 5' N and longitudes of 80° 15' E - 84° 20' E. It is landlocked by Madhya Pradesh, Maharashtra, Orissa, Jharkhand and Andhra Pradesh and Pendra is located at 22°77'N latitude and 81°96'E longitude in Chhattisgarh state. State has three agro-climatic zones (ACZ) Chhattisgarh plains, Bastar plateau and Northern hills zone where Pendra comes under Chhattisgarh plain zone.

MATERIALS AND METHODS

Daily and monthly minimum and maximum temperature (°C) for Pendra were collected from the weather database of department of Agrometeorology IGKV Raipur for the period of 1904-2013 (110 years). Daily temperature data were first calculated as seasonal and annual temperature using weather cock software (Rao *et al.,* 2011) and temperature trend analyzed. Several tests are available for the detection and estimation of trends. In this particular study, Mann-Kendall's test was employed. Mann-Kendall's test is a non-parametric method, this method tests whether there is a trend in the time series data using a linear regression model, the rate of change is defined by the slope of regression line. It is a non-parametric test. Then time series values (X_1, X_2, X_3,….., X_n) are replaced by their relative ranks (R_1, R_2, R_3,….., R_n) (starting at 1 for the lowest up to n). The collected data has been processed and analyzed by preparing various graphs. Winter season (Jan–Feb), summer season (March–May), SWM season (June –Sep), Post monsoon season (Oct–Dec).

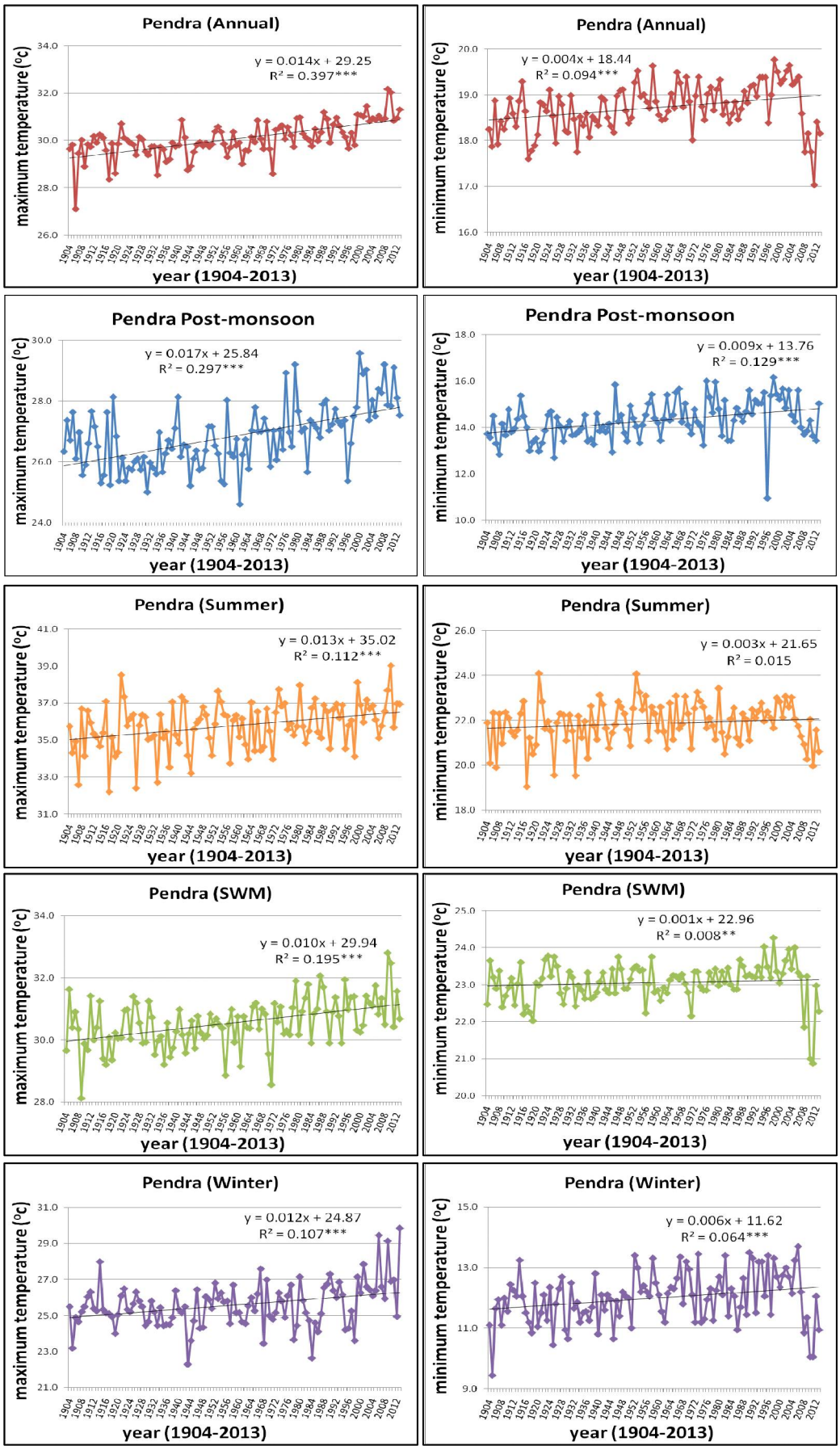

Fig. 1. Annual and seasonal maximum and minimum temperature trend in Pendra

The test statistic S is:

$$s = \sum_{i-1}^{N-1} \sum_{j=i+1}^{N} sgn(R_j - R_i)$$

Where:

$$sgn(X) = \begin{cases} +1 \; for \; (X) > 0 \\ 0 \; for \; (X) \; = 0 \\ -1 \; for \; (X) < 0 \end{cases}$$

If the null hypothesis Ho is true, then S is approximately normally distributed with:

$$\mu = 0$$

$$\sigma = n(n-1)(2n+5)/18$$

The z-statistic is therefore (critical test statistic values for various significance levels can be obtained from normal probability tables):

$$Z = |S|/\sigma^{0.5}$$

A positive value of S indicates that there is an increasing trend and vice versa.

This technique is based on the detection of trends and change point(s) and attaching to it a probability significance level in a time series. This test has been widely used climatologic data analysis (Libiseller and Grimvall, 2002; Lazaro *et al.*, 2001; Mirza *et al.*, 1998).

RESULTS AND DISCUSSION

Mean annual temperature trend

During the period of study (1904-2013) results revealed that the maximum and minimum average temperature found 30.1°C and 18.7°C and long term average annual maximum and minimum temperature trend is observed increasing at 1% level of statistically significance and the rate of change is found 0.014°C/yr and 0.004°C/yr as shown in Fig. 1.

Winter Season temperature trend

This is coldest season of the year on the basis of winter season maximum and minimum average temperature results found 25.6°C and 12.0°C that is lowest as compare to the other seasons and pattern of maximum and minimum temperature is found rising at 0.012°C/yr and 0.006°C/yr at 1% level of significance.

Summer season temperature trend

Summer season is known as warmest season of the year. analysis of summer season's temperature data results showed that average temperature found highest 35.8°C as compare to other seasons and minimum temperature is found 21.9°C and the pattern of maximum temperature trend is observed increasing at 1% level of statistically significance and the rate of change is found 0.013°C/yr but in case of minimum temperature trend is not found significantly increasing or decreasing.

Southwest monsoon (SWM) temperature trend

SWM is very important season during this season maximum and minimum temperature is also plays important role in the germination of seed and different growth stages of different crops grown in *Kharif* season. During this season long term average maximum and minimum temperature results found 30.5°C and 23.1°C and its pattern of changes is observed increasing at 1% and 5% level of significance and rate of change is found 0.010°C /yr and 0.001°C/yr.

Post-monsoon (PM) season temperature trend

Maximum and minimum average temperature during post monsoon season found 26.8°C and 14.3°C this season is known as *Rabi* season that is suitable for lower water requirement crops *viz.* vegetables and pulses and some leguminous fodder or green manuring crop etc, the maximum and minimum temperature also important for its growth and development. Results of post-monsoon season average Maximum and minimum temperature trends found to be increasing at 1% level of statistically significance and rate of change is found 0.017°C/yr and 0.009°C/yr.

At Pendra, seasonal and annual maximum temperature trend found increasing pattern at 1% level of significance and the slope of regression line found between 0.01°C to 0.017°C for the period of 1904-2013 whereas minimum temperature during winter, post-monsoon (PM) season and annual found increasing trend at 1% level of significance and during SWM season result found increasing trend @ 5% level of significance. Minimum temperature during post-monsoon season

the slope is found 0.009°C during the period of study.

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