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Rainfall and temperature trends at three representative agroecological zones of Bihar

A. ABDUL HARIS, V. CHHABRA and S. BISWAS

ICAR Research Complex for Eastern Region, P.O.-B.V. College, Patna – 800 014

ABSTRACT

Rainfall and temperature trends were investigated at four stations representing three agroecological zones of Bihar using 45 years data except for Sabour (34 years) and Madhepura (43 years). Monthly, seasonal and annual precipitations as well as temperature (Tmax and Tmin) were analyzed for climate variability and possible trends using nonparametric Mann-Kendal statistic test. The results showed an increasing trend in rainfall and minimum temperature, on the contrary a decreasing trend for maximum temperature in the study area.

Key words: Rainfall, maximum and minimum temperature, Mann-Kendall test

Climate change is very likely to have a major impact on hydrological cycle and consequently on available water resources, flood and drought frequencies, natural ecosystems, society and the economy (Ramos, 2001). A disruption of water supply through natural hazards can result in social, agricultural and economic losses that often take years to recover. In particular, major phenomena related to changes in the composition of the atmosphere such as the anthropogenic release of greenhouse gases are expected to have a significant effect on the climate. Temperature increases and precipitation pattern changes have occurred all over the world during this century and are predicted to change further. Such climatic changes may entail the occurrence of specific undesirable effects on agriculture. According to IPCC (2001), the global average surface temperature increased over the 20th century by about 0.6 °C and temperatures have risen in the past four decades in the lowest eight kilometers of the atmosphere. According to many researches, climate change signs and evidences are not same over the entire globe. In certain areas an increase of rainfall or decrease of temperature is expected, while other areas at the same time may suffer from decreased rainfall or increased temperature. Although, increasing or decreasing trends in annual, seasonal and monthly rainfall are indicated by many research findings, but such trends vary spatially and temporally. Hidalgo *et al.* (2001) found a significant decrease in rainfall amount associated with a significant increase in interannual variability in more humid areas of Valencia. Based on parametric and nonparametric statistics tests, Xu *et al.* (2003) concluded that annual national precipitation of Japan experienced step changes while there is no evidence for any monotonic trend. The aim of this study was to analyze the possible trends of rainfall and temperature at four centers falling in different agroecological zones of Bihar based on the observed historical weather time series and weather data of recent years.

MATERIALS AND METHODS

Rainfall and temperature (maximum and minimum) were analyzed for studying the significant features of climatic variability at four centres viz. Pusa, Madhepura, Patna and Sabour of Bihar in Eastern India, present in agroecological Zone I, Zone II, Zone III A and Zone III B respectively. Annual, seasonal, monthly rainfall and temperature were analyzed by using Mann-Kendall test and the level of significance was tested at 10%. Rainfall and temperature data for the four stations of Bihar were used (1961-2005 for Pusa and Patna, 1961-2003 for Madhepura and for 1972-2005 at Sabour).

RESULTS AND DISCUSSION

Annual rainfall

Rainfall showed an increasing trend for Patna, Pusa and Sabour during 1961-1990 (baseline) and from 1991-2005 (post 1990), except at Madhepura where a decreasing trend was observed for baseline (Fig 1). Increase in rainfall was significant for Patna and Sabour for baseline and only for Patna post 1990.

Annual maximum and minimum temperature

For baseline, annual maximum temperature showed negative trend for Madhepura and Patna but decrease was significant only at Madhepura. Both Patna and Sabour showed increasing trend for minimum temperature with significant increase in Patna, while at other two stations a significant decrease was observed in minimum temperature.

Post 1990, maximum temperature showed decreasing, while minimum temperature showed increasing trend for all the stations. Maximum temperature showed significant decrease for Madhepura, Patna and Pusa. Significant

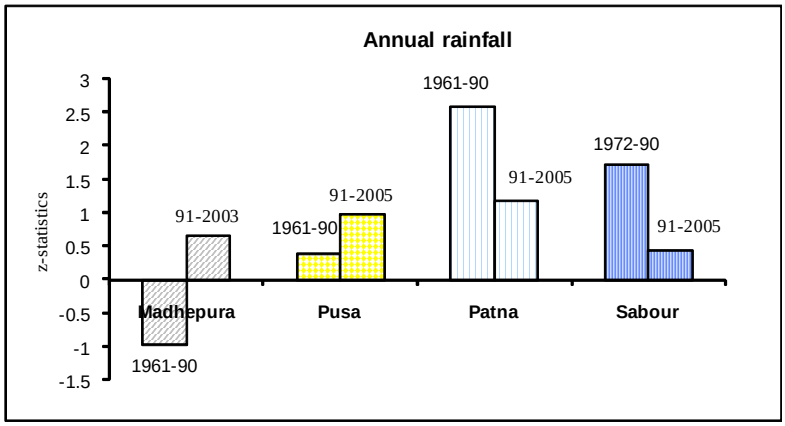

Fig. 1: Mann-Kendall test statistics for annual rainfall

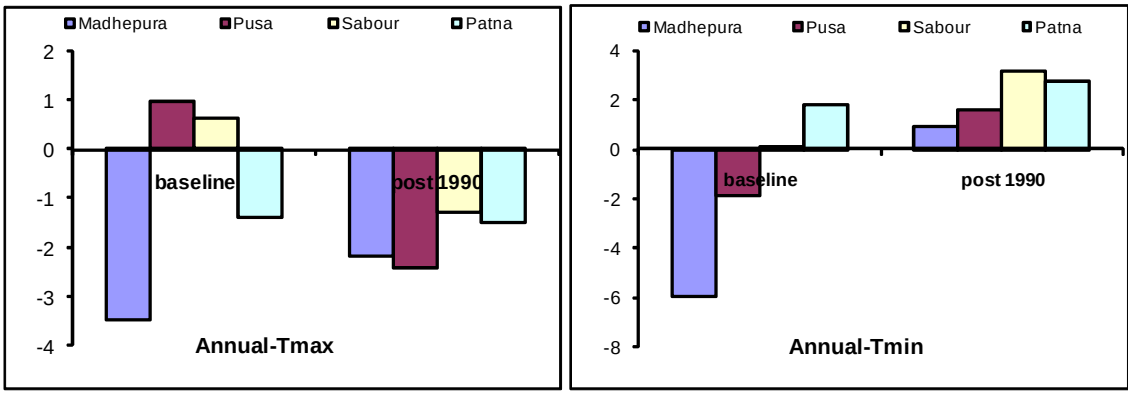

Fig. 2: Mann-Kendall test statistics for annual maximum and minimum temperature trend

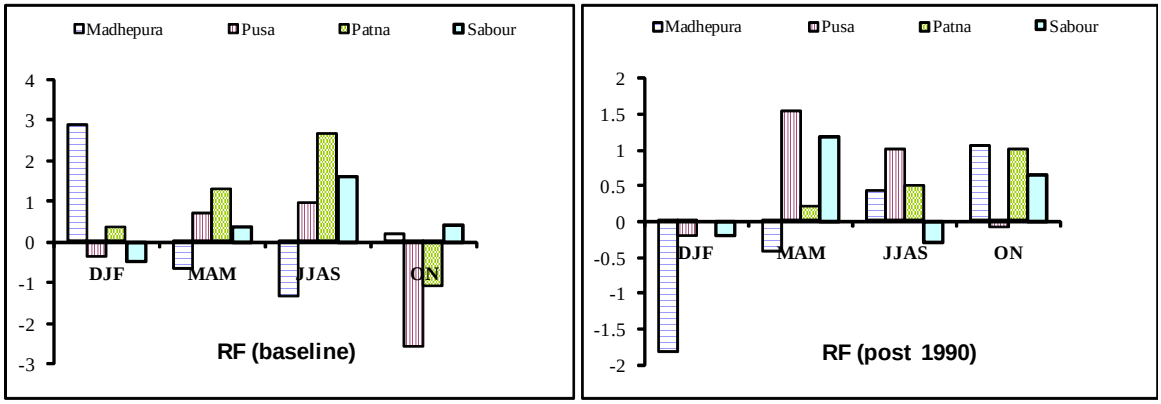

Fig. 3: Mann-Kendall test statistics for seasonal rainfall trend

increase in minimum temperature was observed for Pusa, Patna and Sabour (Fig 2).

Seasonal rainfall

For baseline, an increasing trend in rainfall was observed for all stations except Madhepura during monsoon (JJAS) and pre-monsoon (MAM) seasons; significant increase was noted for Patna and Sabour for monsoon season. In the post-monsoon season (ON) an increase in rainfall was observed at Madhepura and Sabour. The decrease in post monsoon rainfall was significant for Pusa. Rainfall at Madhepura during winter season (DJF) showed a significant increase.

Table 1: Seasonal trend of maximum and minimum temperatures

Maximum temperature								
	Baseline				Post 1990			
Seasons	Pusa	Patna	Madhepura	Sabour	Pusa	Patna	Madhepura	Sabour
DJF*	I	I	D	I	D[a]	D[a]	D[a]	D
MAM*	D[a]	D[a]	D[a]	D	D[a]	D	D[a]	D
JJAS*	I	D[a]	D[a]	I	D	I	D[a]	I
ON*	I[b]	I	D	I	D[a]	I	D[a]	D[a]
Minimum temperature								
	Baseline				Post 1990			
	Pusa	Patna	Madhepura	Sabour	Pusa	Patna	Madhepura	Sabour
DJF	I	I[b]	D[a]	I	I[b]	I[b]	I	I[b]
MAM	I	D	D[a]	D	I[b]	I[b]	I	I[b]
JJAS	D[a]	D	D[a]	I	I	I[b]	I	I[b]
ON	D	I	D[a]	D	I	I[b]	I[b]	I[b]

[a]- significant decrease,[b]- significant increase
*DJF-winter; MAM-summer; JJAS-rainy season; ON-post-monsoon

Post 1990s significant increase in rainfall during pre-monsoon was observed for Pusa and Sabour. During post-monsoon Madhepura, Patna and Sabour showed an increasing trend with significant increase for Madhepura. Significant decrease in winter season was observed for Madhepura only (Fig 3).

Seasonal maximum and minimum temperature

For baseline, Madhepura showed decrease in seasonal maximum temperature for all seasons. At Patna significant decrease in maximum temperature during pre monsoon and monsoon season was observed (Table 1).

Post 1990, a decreasing trend in seasonal maximum temperature was observed for all stations except during monsoon and post-monsoon at Patna and during monsoon season at Sabour.

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