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## Climatic vulnerabilities at Raipur district for Chhattisgarh

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### Abstract

Annual and seasonal variability's in maximum and minimum temperatures and rainfall were analyzed from historical daily meteorological data for Raipur (1971-2013). Two distinct crop growth seasons of *Kharif* (1 May to 31 October) and *rabi* (1 November to 30 April) were characterized for seasonal trends. The analysis of the data revealed that the climate has changed slightly over the past three decades. Both annual as well as seasonal maximum and minimum temperatures exhibited small standard deviation and coefficient of variation indicating minor variations in temperatures. The maximum temperature has remained near normal over the past three decades as the annual and *kharif* season maximum temperature revealed a slight decreasing trend while the *rabi* season maximum temperature revealed a slight increasing trend. On the other hand, the annual *Kharif* and *rabi* minimum temperature have increased significantly at the rate of 0.02 °C /year. The annual as well as seasonal rainfall exhibited high standard deviation and coefficient of variation indicating large variation in rainfall. The five yearly moving average trends in annual rainfall indicated an overall increase of about 3.8 mm/ year which was mainly due to an increase in *kharif* season rainfall (3.5 mm/ year) while the *rabi* season rainfall has remained nearly stable.

**Keywords:** Annual and seasonal rainfall, temperature and climatic variability

### Introduction

Temperature and rainfall are the two important parameters, which affect crop growth and production. The past two decade have witnessed rapid increase in the awareness of global climatic changes and triggered widespread apprehension amongst scientists and governments about their implications (Gadgil, 1996) [3]. Recent reports reveal that climate is changing due to an increase in the concentration of green house gases in the atmosphere (Hundal and Abrol, 1991) [5]. A simulation study to analyses climate change impact on crop productivity in Punjab revealed that increasing temperature trends pose a serious threat towards decreasing growth and yield of cereal and oilseed crops (Hundal and Prabhjot Kaur, 1996) [6]. The all India mean annual surface temperature derived from 73 stations across India showed a significant warming of 0.4 °C over the past 100 years, which is comparable to global mean trend of 0.3 °C increase per 100 years (Hingane *et al*, 1985) [4]. Wigley (1989) [12] reported a warming of 0.5 °C by 1995-2005, 1.5 °C by 2015-2050 and 3.0 °C by 2050-2100. Pant *et al* (1996) [9] analyzed mean rainfall over South Asian region for a period of 1813-1980 and reported a statistically increasing long term trend. However, an analysis of a representative rainfall series over the past 176 years for India as a whole by Sontakke (1990) [11] does not suggest any significant trend. Hundal *et al* (1997) [7] analysed rainfall at Ludhiana over the past 95 years and reported an increasing trend for both annual as well as *Kharif* season rainfall in the past 30 years at Ludhiana. The global temperatures have risen by 0.85 °C since 1880, with the fastest increases since 1950. Surface temperatures will rise by between 0.3 °C and 4.8° C above pre-industrial levels by 2100, with most models predicting an increase of at least 1.5 °C and little chance of a rise below 2 °C (Raju Kumar *et al*, 2013) [10]. Keeping in view the importance of climatic variability, the present study was undertaken to assess changes in rainfall and temperature at Raipur.

### Materials and Methods

The variability analysis was carried out by analyzing historical data of temperatures and rainfall for Raipur (21°16" N, 81°36" E, 289.6 m above mean sea level).

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The daily maximum and minimum air temperatures and rainfall data of past 43 years (1971-2013) at Raipur was analyzed for annual as well as *kharif* (1 May to 31 October) and *rabi* (1 November - 30 April) crop growing seasons, five year moving averages, standard deviation (s.d.) and coefficient of variation (c.v.).

## Results and Discussion

### 1. Temperature

**(a) Annual trends:** The standard deviation and coefficient of variation for Raipur station was small for maximum and minimum temperatures indicating only a minor year to year variation. The maximum temperature gave a s.d. 0.50 °C and c.v. 1.54 per cent (Table 1). The minimum temperature variability showed s.d. 0.71 °C and c.v. of 3.58 percent.

The five-yearly moving averages of annual maximum/minimum temperatures for Raipur are shown in Fig 1. In general, the annual maximum temperature increased over the past three decades at Raipur, though no significant trend could be observed. On the other hand, the annual minimum temperature has increased at the rate of 0.02 °C /year over the past three decades at Raipur.

**(b) Kharif season trends:** Like annual temperatures the s.d. and c.v. were small for maximum and minimum temperatures

during *kharif* season (Table 1). The maximum temperature showed s.d. of 0.68 °C and c.v. of 2.03 percent at Raipur (Table 1). The minimum temperature data showed a s.d. of 0.73 °C and c.v. of 3.0 percent at Raipur. From the five-yearly moving averages of *kharif* season maximum/minimum temperatures for the Raipur station, it is evident that the maximum temperature decreased at the rate of 0.001 °C /year over the past three decades while minimum temperature increased significantly at the rate of 0.015 °C/year over the past three decades.

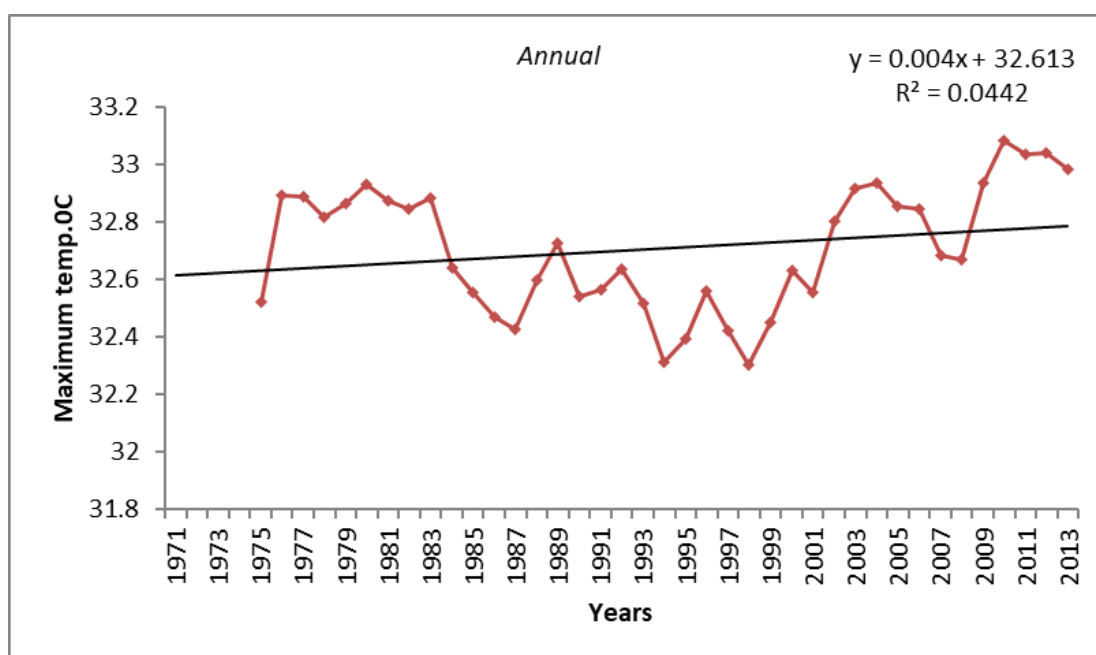
**(c) Rabi season trends:** The c.v. was comparatively larger for minimum temperature 5.5 as compared to maximum temperature 1.9 (Table 1). The maximum temperature showed s.d. 0.61 °C and c.v. 1.94 per cent while minimum temperature gave a s.d. 0.85 °C and c.v. 5.56 per cent at the Raipur station.

The five year moving averages of *rabi* season maximum / minimum temperatures for Raipur are shown in Fig 3. At Raipur the *rabi* season maximum temperature showed no significant trend though a slight increase could be observed over the past three decades. On the other hand like annual and *kharif* season, the *rabi* season minimum temperature increased significantly at the rate of 0.02 °C/year at Raipur.

**Table 1:** Annual *kharif* and *rabi* season temperature and rainfall features at Raipur

Weather parameters	Annual	<i>Kharif</i> season	<i>Rabi</i> season
		Maximum temperature(°C)	
Mean (°C)	32.68	33.74	31.62
S.D. (°C)	0.50	0.68	0.61
C.V. (%)	1.54	2.03	1.94
		Minimum temperature(°C)	
Mean (°C)	19.79	24.26	15.32
S.D. (°C)	0.71	0.73	0.85
C.V. (%)	3.58	3.00	5.56
		Rainfall (mm)	
Mean (mm)	1202.19	1126.37	75.82
S.D. (mm)	277.23	271.09	47.21
C.V. (%)	23.06	24.07	62.27

### (a) Trend analysis of annual maximum and minimum temperature at Raipur



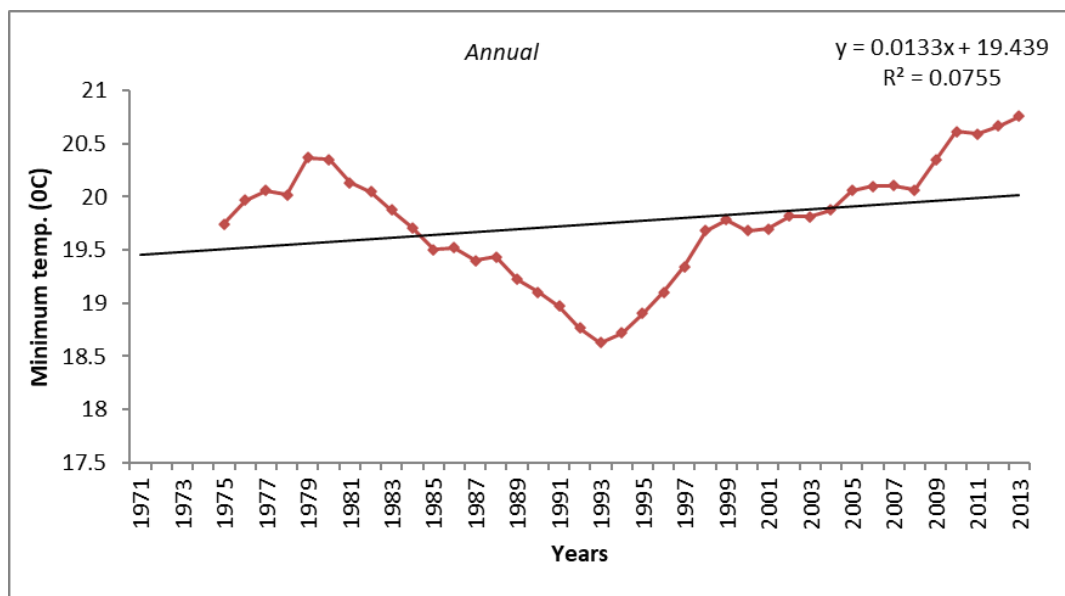


Fig 1: Annual maximum and minimum temperature (Five yearly moving average) at Raipur

(b) Trend analysis of *kharif* season maximum and minimum temperature at Raipur

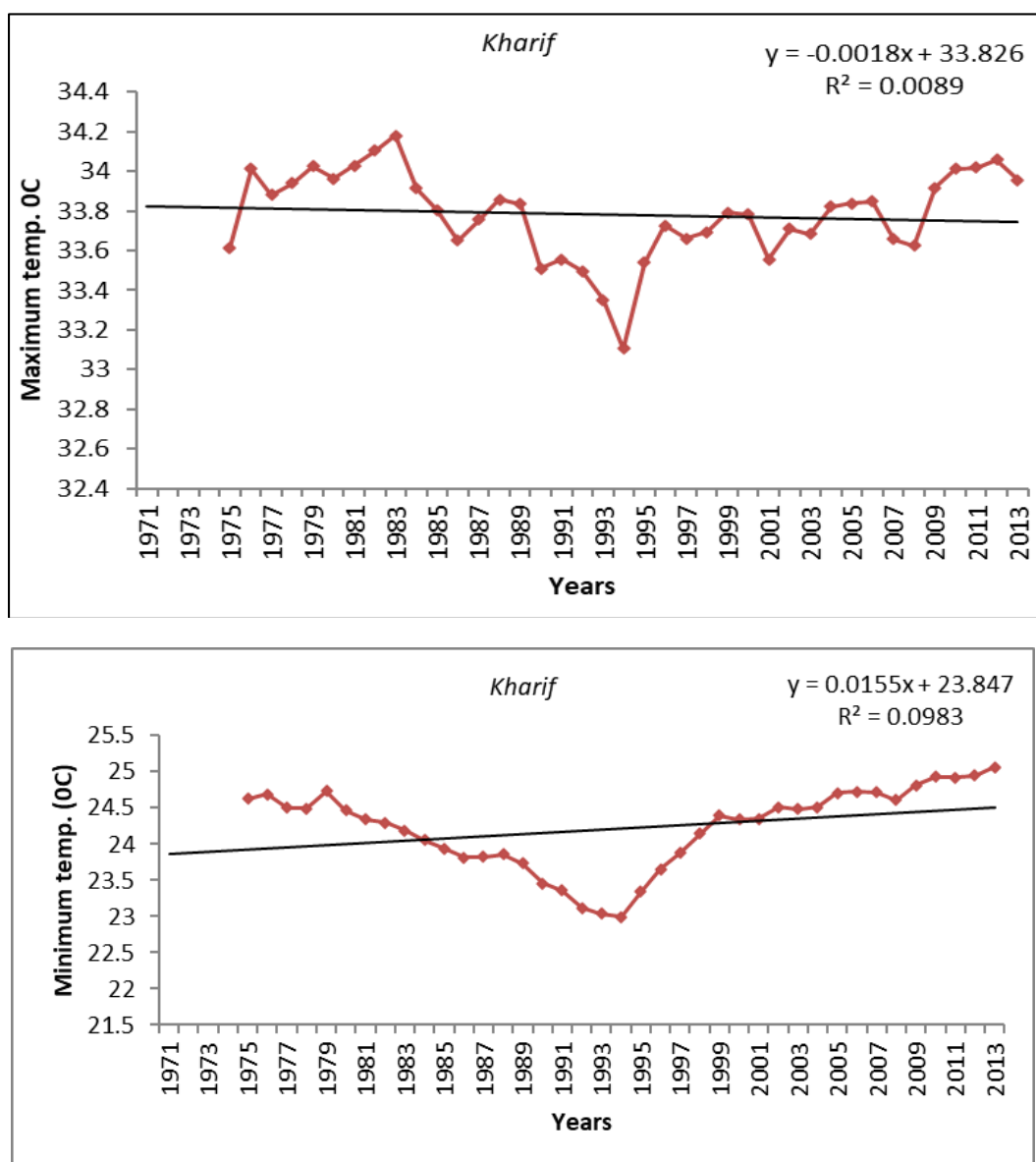
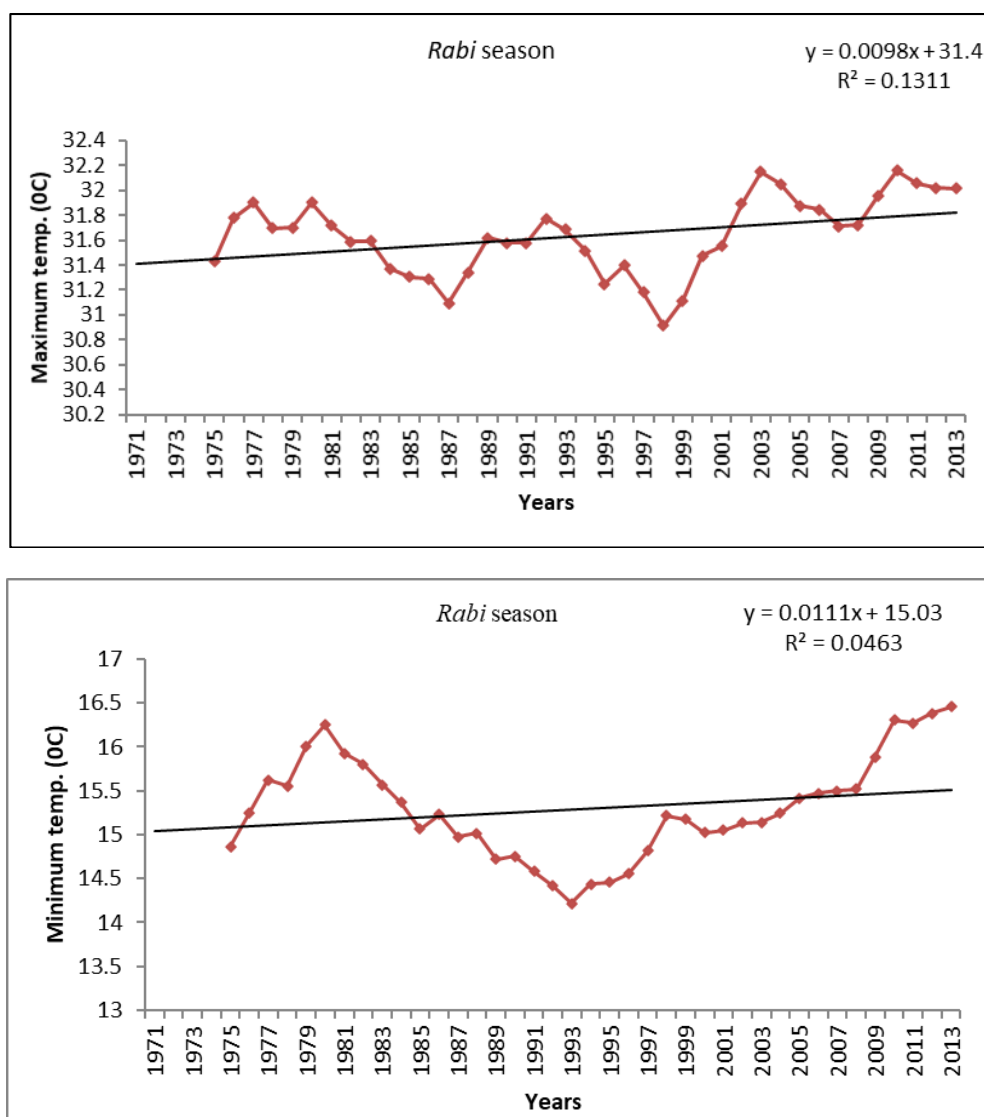
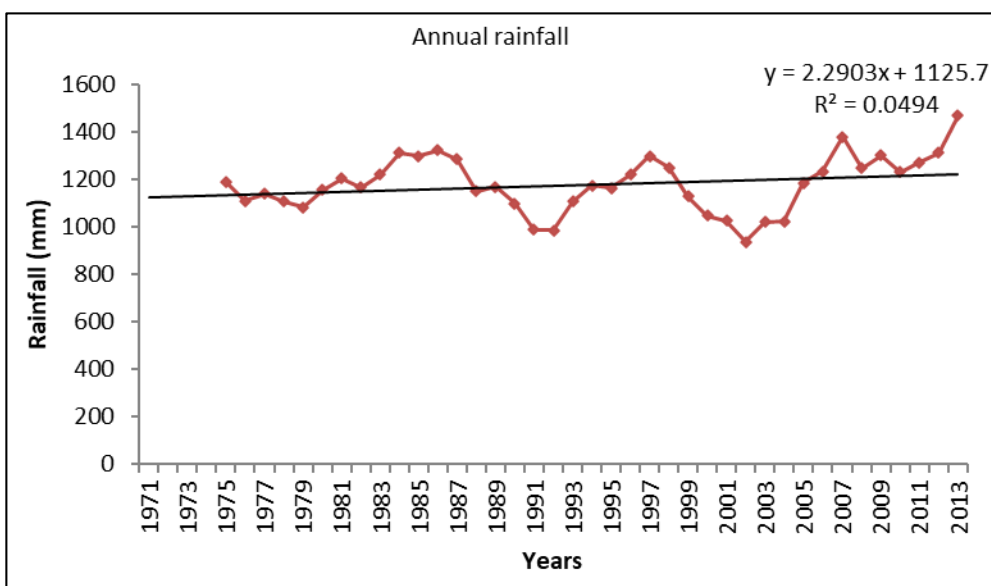


Fig 2: *Kharif* season maximum and minimum temperature (Five yearly moving average) at Raipur

**(c) Trend analysis of *rabi* season maximum and minimum temperature at Raipur****Fig 3:** *Rabi* season maximum and minimum temperature (Five yearly moving average) at Raipur**(abc) Trend analysis of Annual, *kharif* and *rabi* season rainfall at Raipur**

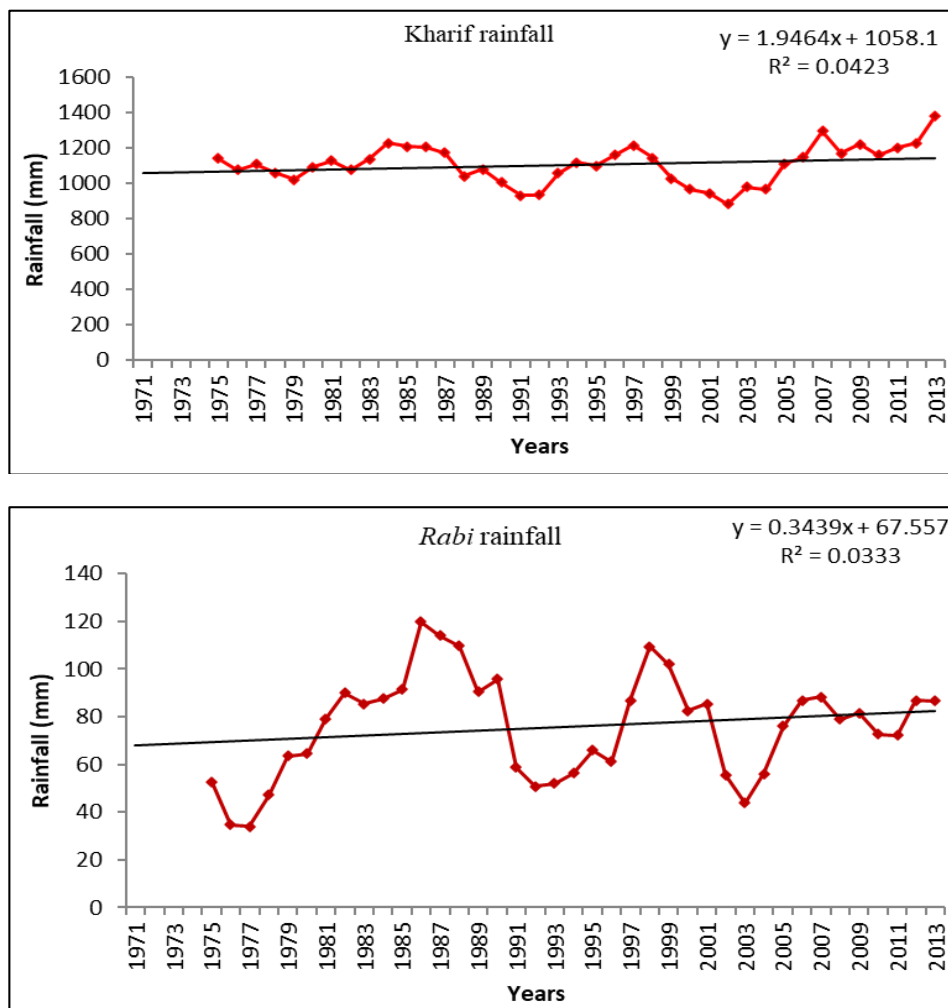


Fig 4: Annual *kharif* and *rabi* season rainfall (Five yearly moving average) at Raipur

## 2. Rainfall

**(a) Annual Trends:** The rainfall variability showed a s.d. of 277.23 mm and c.v. of 23.06 per cent at Raipur (Table 1). The large s.d. and c.v. values for annual rainfall for the time series indicates high variability in annual rainfall for Raipur station. The five year moving average of annual rainfall revealed that rainfall increased significantly at the rate of 2.23 mm/year over the past three decades at Raipur.

**(b) Kharif season trends:** The rainfall variability gave a s.d. of 271.09 mm and c.v. of per cent for Raipur. The large s.d. and c.v. for *kharif* season rainfall for the time series indicate high variability in seasonal rainfall at Raipur. In general, the *Kharif* season rainfall increased at the rate of 1.94 mm/year thereby indicating that increase in annual rainfall was due to increase in *kharif* season rainfall (Fig 4).

**(c) Rabi season trends:** The *rabi* season rainfall accounts for 6 per cent of the total rainfall. The rainfall variability showed a s.d. of 47.21 mm with c.v. of 62.27 per cent at Raipur. The s.d. values are comparably smaller but c.v. values were comparably larger for *rabi* season rainfall as compared to annual and *kharif* season rainfall at Raipur. No significant trend was observed in the *rabi* season rainfall over the past three decades (Fig 4). The analysis in this study indicated that the minimum temperature and rainfall increased significantly over the past four decades at Raipur. However, the maximum temperature decreased only slightly over the past four decades.

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