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Sumant Prasad
Department of Agriculture
Meteorology N.D. University of
Agriculture & Technology,
Kumarganj, Faizabad,
Uttar Pradesh, India

AN Mishra
Department of Agriculture
Meteorology N.D. University of
Agriculture & Technology,
Kumarganj, Faizabad,
Uttar Pradesh, India

AK Singh
Department of Agriculture
Meteorology N.D. University of
Agriculture & Technology,
Kumarganj, Faizabad,
Uttar Pradesh, India

Manoj Kumar
Krishi Vigyan Kendra, Ganiwan,
Chitrakoot, Uttar Pradesh, India

Corresponding Author:
Sumant Prasad
Department of Agriculture
Meteorology N.D. University of
Agriculture & Technology,
Kumarganj, Faizabad,
Uttar Pradesh, India

Climatic variability analysis of district Bahraich of Uttar Pradesh

Sumant Prasad, AN Mishra, AK Singh and Manoj Kumar

Abstract

The historical data of weather parameters especially rainfall and temperature (maximum and minimum) of district Bahraich of U.P. were collected for study from the period of 1987-2016. Result reveals that in district Bahraich of U.P., the annual trend of rainfall have been studied using annual data series of 30 years (1987-2016) and divided into three decades which is 1987-1996, 1997-2006 and 2007-2016 respectively. Annual rainfall of Bahraich gradually declined over the normal 1036.2 (mm) in recent years. Annual average maximum temperature of district Bahraich of U.P. was found increasing trend over normal average maximum temperature (31.1 °C) during 30years (1987-2016) period. Rise in average maximum temperature by 2.2 °C was found in the year 2009 over the normal temperature of district Bahraich of U.P. A slight increasing trend of average minimum temperature of about 1.92°C over the normal average minimum temperature (18.08 °C) was observed. Average temperature was increased by 1.7 °C over normal average temperature within this 30 years period. A decreasing trend of rainfall and increasing trend of both maximum and minimum temperature resulted into decreased agricultural production with respect to the present grain need scenario for the world population.

Keywords: Rainfall trend, annual rainfall variability, decadal, linear regression analysis

Introduction

Agriculture and related sectors, food security and energy security of India are crucially dependent on the timely availability of adequate amount of water and a conducive climate. The rainfall received in an area is an important factor in determining the amount of water available to meet various demands such as agricultural, industrial, domestic water supply and for hydroelectric power generation. Global climate changes may influence long-term rainfall patterns impacting the availability of water along with the danger of increasing occurrences of droughts and floods. Changes in climate over the Indian region, particularly the SW monsoon, would have a significant impact on agricultural production, water resources management and overall economy of the country. The heavy concentration of rainfall in the monsoon months (June-September) results in scarcity of water in many parts of the country during the non-monsoon periods.

Change in rainfall due to global warming or after 1990's (after industrialization) in the country, may influence the hydrological cycle and rainfall pattern. This compelled to review the demand of water hydrological design and agricultural practices. Therefore, long term trend analysis of rainfall and other weather parameters on different spatial scales will help in framing the future scenario for crop planning and management (Jain & Kumar, 2012) [2]. Keeping above facts in view the present investigation was under taken.

Materials and Methods

The rainfall data of last 30 years (1987-2016) of Bahraich (Uttar Pradesh) were collected. Data were analyzed for observing the past trend of rainfall and temperature. Bahraich is situated at 27°58' N Latitude, 81°55' E Longitude and altitude 126 m at mean sea level (MSL). Bahraich comes under North Eastern Plain Zone U.P. state in India. In North Eastern Plain Zone, consists of 11 districts, namely Bahraich, Shravasti, Gonda, Balrampur, Basti, Siddharthnagar, Sant Kabir Nagar, Gorakhpur, Maharajganj, Padrauna and Deoria. Eastern parts of U.P. has been divided into three agro-climatic zones, namely North eastern plain zone (NEPZ), Eastern plain zone (EPZ) and Vindhyan zone (VZ). As Eastern U.P. stretches from North India towards Eastern, the rainfall of NEPZ of U.P. is higher about 1270 mm as compared to other region of eastern U.P. and with drawl of monsoon is also in similar trend i.e. earlier in NEPZ. Trend analysis for different climatic parameters were done for the Bahraich district of NEPZ region.

Results and Discussions

Annual rainfall variability (mm)

Data pertaining to annual (January to December) rainfall variability (mm) of Bahraich have been presented in Fig.1. Data analysed over last 30 years (1987-2016) reveals that annual rainfall (mm) of Bahraich declined over normal 1036.2

mm in recent years to come. The decreasing trend was found in annual rainfall variability (mm) over the normal rainfall which is directly influenced the production of rice and maize (about 80% of maize is cultivated during monsoon season). Untimely and distribution of rainfall also occurs due to climatic variability.

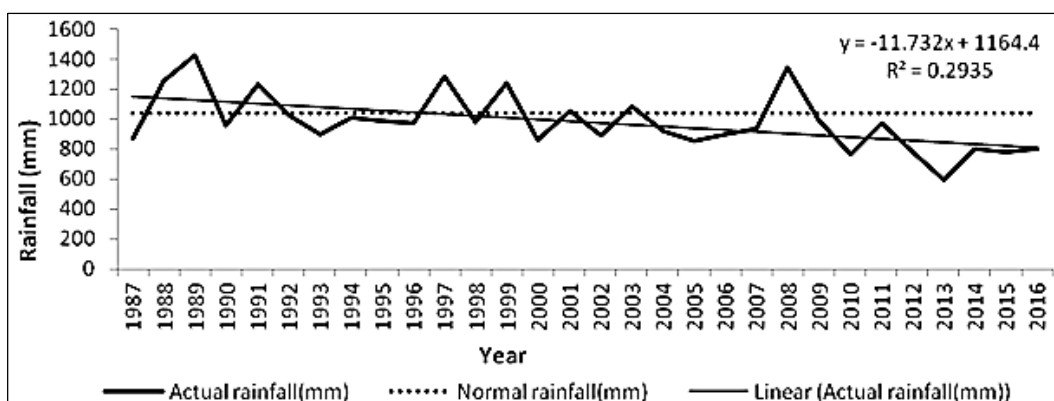


Fig 1: Annual rainfall variability (mm) of district Bahraichof U.P.

Decadal rainfall variability

The rainfall data analysed over last 30years (1987-2016) and divided into three decades to know which decades starts the decreasing trend of rainfall as illustrated in Fig.- 2, Fig.- 3 and Fig.- 4, which was First (1987-1996), second (1997-2006) and third (2007-2016) decades respectively. It is quite observable from the data analysed over last 30years (1987-2016) that annual rainfall (mm) of Bahraich declined over normal rainfall 1036.2 mm in recent years to come while trend of annual rainfall in First decade was found slightly decrease

over the normal rainfall. In first decade the year 1988, 1989 and 1991 highest rainfall recorded which is higher over the normal rainfall. First year (1997) of second decade highest 1285.7mm rainfall recorded which is higher over normal rainfall. In the year of 1999 and 2003 recorded higher rainfall over normal rainfall. After the year of 2001 rainfall decreasing trend found over normal rainfall. In third decade (2007-2016) year 2008 highest rainfall 1346.54mm recorded which is portrayed in Fig-4. So, trend of annual rainfall in third decade found decreasing over normal.

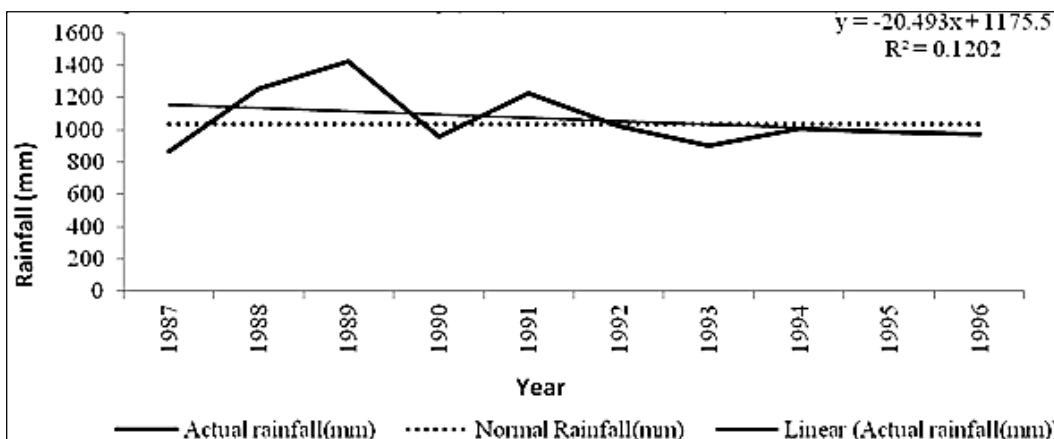


Fig 2: Decadal rainfall variability (mm) of districtt Bahraich (1987-1996)

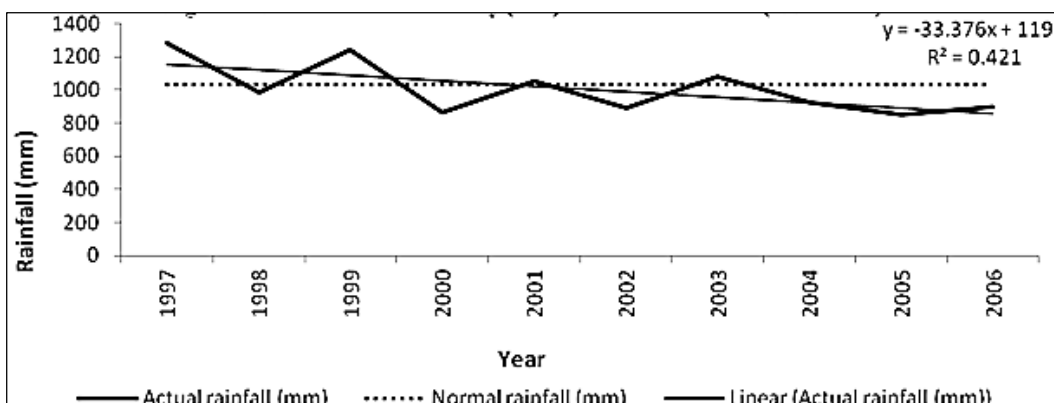


Fig 3: Decadal rainfall variability (mm) of district Bahraich (1997-2006)

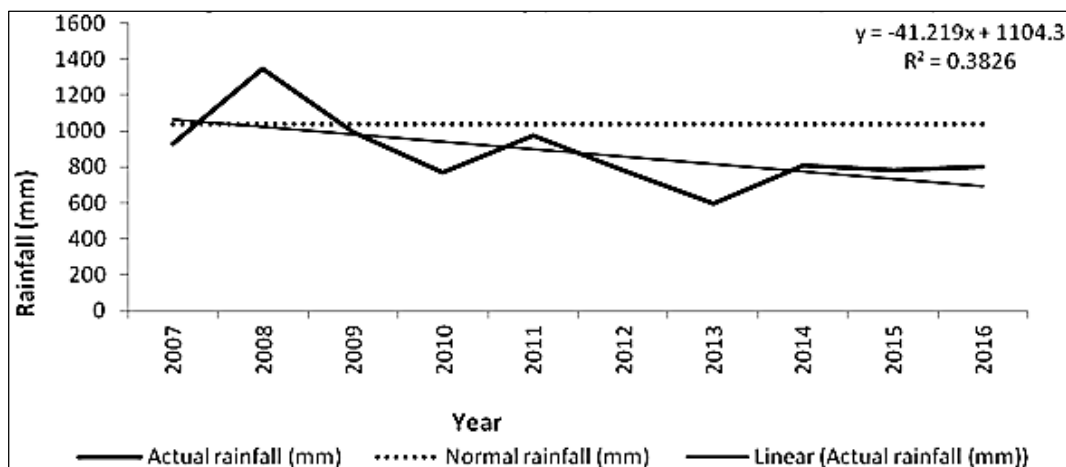


Fig 4: Decadal rainfall variability (mm) of district Bahraich (2007-2016)

Annual variation of average maximum temp. ($^{\circ}$ C) of Bahraich

Data pertaining to annual average maximum temperature of Bahraich have been presented in table-1. Data analysed over last 30years (1987-2016) that annual average maximum temperature of Bahraich increased over normal average maximum temperature 31.1° C in recent years to come. The highest annual average maximum temperature in the year of

2009 was 33.3° C which is above the normal average maximum temperature while lowest average maximum temperature 30.8° C was found in the year of 1997. From 1987 to 2016, there was a major fluctuation of temperature, approximately between 31.1° C to 33.3° C. Thereafter, rise of average maximum temperature of about 2.2° C was found during 2009. There was a large increasing trend of average maximum temperature found during 30 years (1987-2016).

Table 1: Annual average maximum temperature ($^{\circ}$ C) of Bahraich

Year	Temperature ($^{\circ}$ C)
1987	31.2
1988	31.8
1989	31.8
1990	32.1
1991	31.5
1992	31
1993	31.3
1994	32.1
1995	32
1996	31.8
1997	30.8
1998	31
1999	31.8
2000	32
2001	31.5
2002	32.3
2003	32.1
2004	32.1
2005	32.6
2006	32.6
2007	32.3
2008	31.8
2009	33.3
2010	32.8
2011	31.7
2012	32.4
2013	31.2
2014	31.3
2015	32.6
2016	32.7

Decadal variation of average maximum temp. ($^{\circ}$ C) of Bahraich

The temperature data analysed over last 30years (1987-2016) and divided into three decades to know which decades starts the increasing trend of maximum temperature as illustrated in Fig.-6, Fig.-7 and Fig.-8, which was first (1987-1996), second (1997-2006) and third (2007-2016) decades respectively. Fig.-

6 represent First decadal variation of average maximum temperature, highest average maximum temperature was 32.1° C in the year of 1990 and 1994 while lowest average maximum temperature of 31° C was found in the year of 1991. So, slightly increasing trend found in first decade of annual average maximum temperature over the normal annual maximum temperature. The highest average maximum

temperature found was 32.6 °C in the year of 2005 and 2006 and lowest average maximum temperature was 30.8 °C in the year of 1997 which is depicted in Fig.-7. So, clearly increasing trend was also found in Second decadal variation of average maximum temperature over the normal average maximum temperature. Only in the year of 1997 and 1998, average maximum temperature was found below the normal average maximum temperature. After the year of 1997 increasing trend found in second decadal variation of average maximum temperature. The third decadal variation of average

maximum temperature is shown in Fig.-8, the highest average maximum temperature found was 33.3 °C in the year of 2009 and lowest average maximum temperature was 31.2 °C in 2013. In this decade there was found a slightly decrease trend. From 2007 to 2016, all the year temperature was found higher compare to normal average maximum temperature except year 2013. The fluctuation of average maximum temperature of about 2.2 °C was seen during 2007 to 2016 which illustrated in Fig.-8 (Anonymous, 2015)^[1].

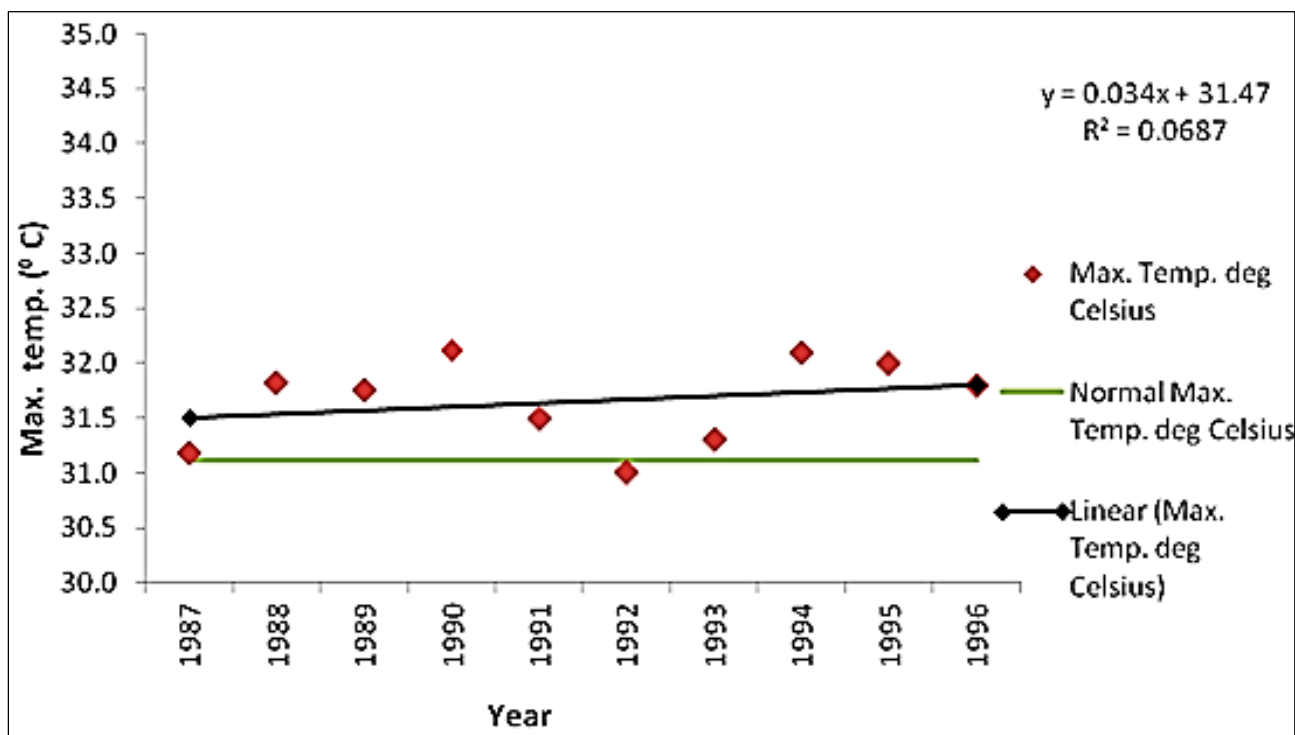


Fig 5: Decadal variation of average maximum temperature (1987-1996)

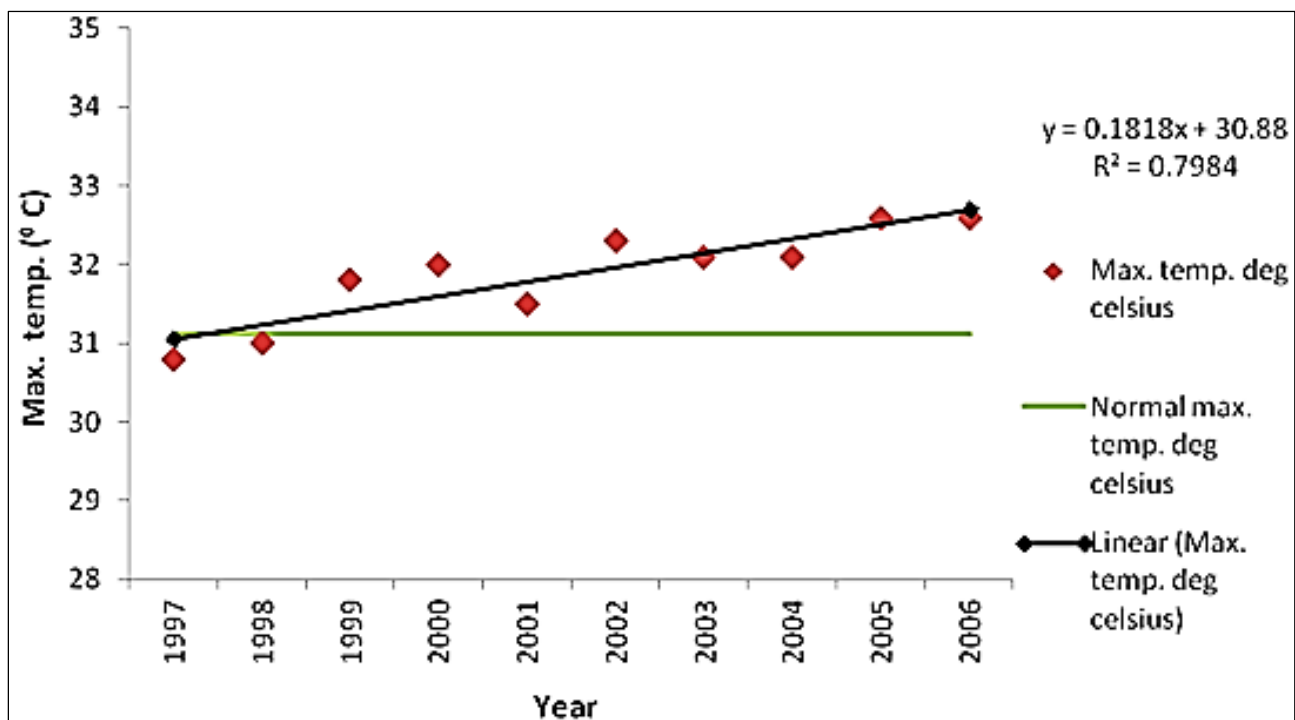


Fig 6: Decadal variation of average maximum temperature (1997-2006)

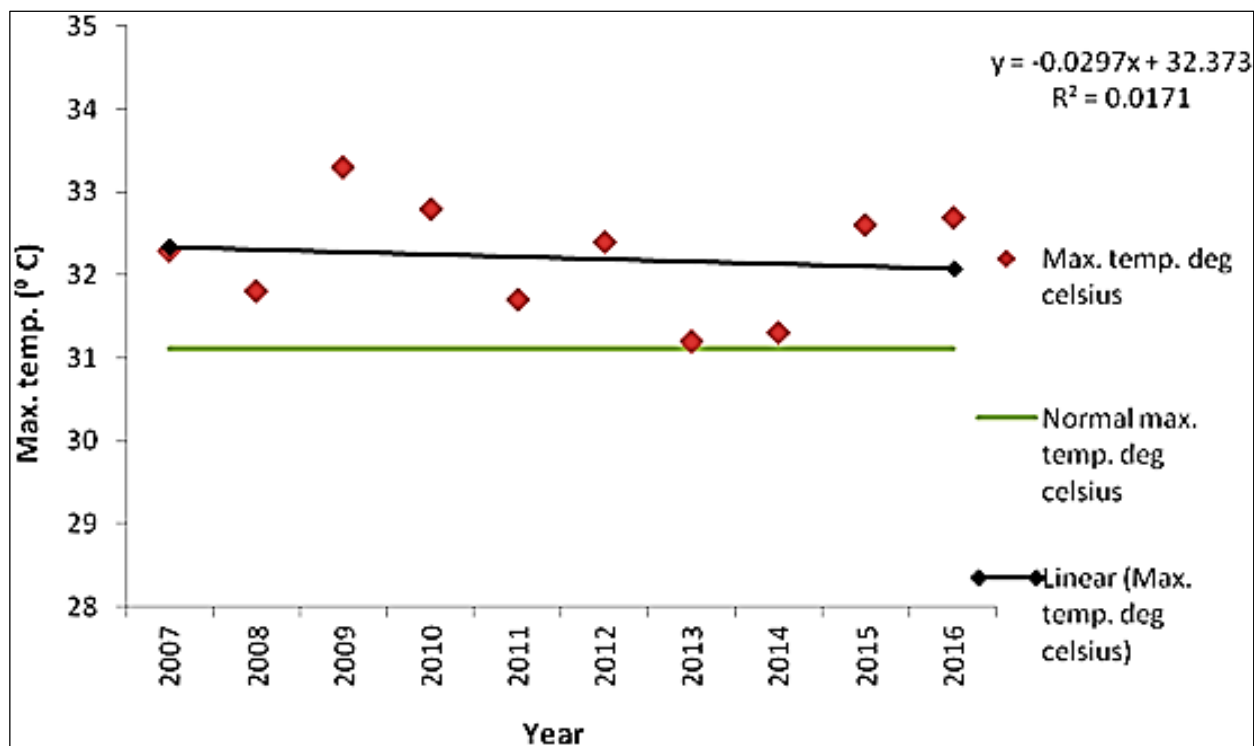


Fig 7: Decadal variation of average maximum temperature (2007-2016)

Annual variation of average minimum temp. (°C) of Bahraich

Data pertaining to annual average minimum temperature of Bahraich have been presented in Table 2. Data was analysed over last 30years (1987-2016) that annual average minimum temperature of Bahraich gradually increased over normal average minimum temperature 18.08 °C in recent years to

come. It showed larger variations of temperature over 30years. The highest annual average minimum temperature in the year of 1992 was 20 °C which is above the normal average maximum temperature while lowest average minimum temperature 15°C was found in the year of 1987. A slightly increase trend of about 1.92° C was found in average minimum temperature the year of 1992.

Table 2: Annual average minimum temperature (°C) of Bahraich

Year	Temperature (°C)
1987	15
1988	19
1989	18.9
1990	18.1
1991	18.2
1992	20
1993	18.6
1994	17.5
1995	18.9
1996	18.3
1997	18.4
1998	19.1
1999	18.7
2000	17.8
2001	18.1
2002	18.7
2003	18
2004	18.1
2005	18.3
2006	18.9
2007	17.8
2008	18.6
2009	19.3
2010	19
2011	18.3
2012	17.9
2013	18.1
2014	17.7
2015	18.2
2016	18.8

Decadal variation of average minimum temp. (°C) of Bahraich

There was small increasing trend in the behavior of average minimum temperature over the normal. In the year of 1987, average minimum temperature 15 °C was found which is below the normal average minimum temperature and that was the lowest minimum average temperature of first decade. The highest average minimum temperature was found 20 °C in the year of 1992. Fig.-11 represents second decadal variation of

average minimum temperature (Jain and Kumar; 2012; Kumar *et.al.* 2016) [2, 3]. There was found slightly increase trend of average minimum temperature after the year of 1991. The highest average minimum recorded in the year of 1998, 19.1 °C and the lowest was 17.8 °C in the year of 2000. The fall of average minimum temperature of about 1.3 °C was found during 2000. In third decade highest average minimum temperature was found 19 °C in the year of 2010 and lowest recorded 17.7 °C during 2014 which is depicted in Fig.-12.

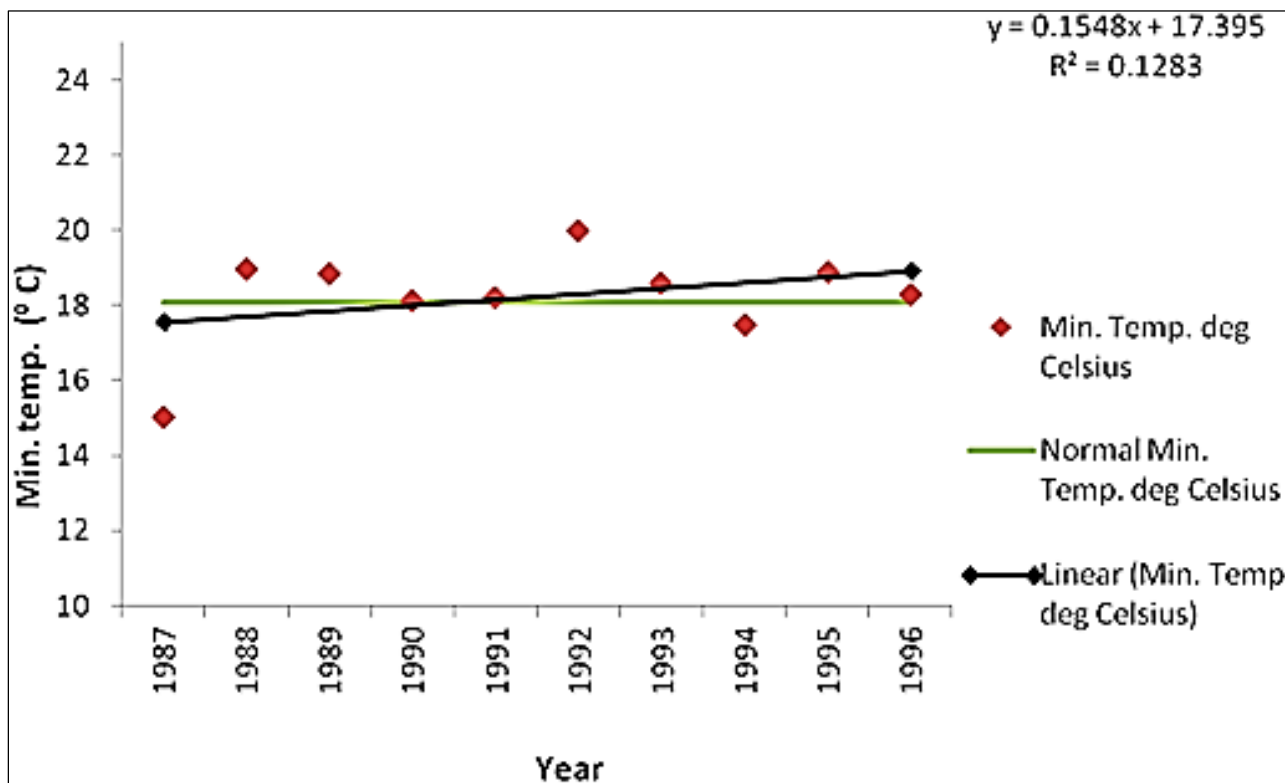


Fig 8: Decadal variation of average minimum temperature (1987-1996)

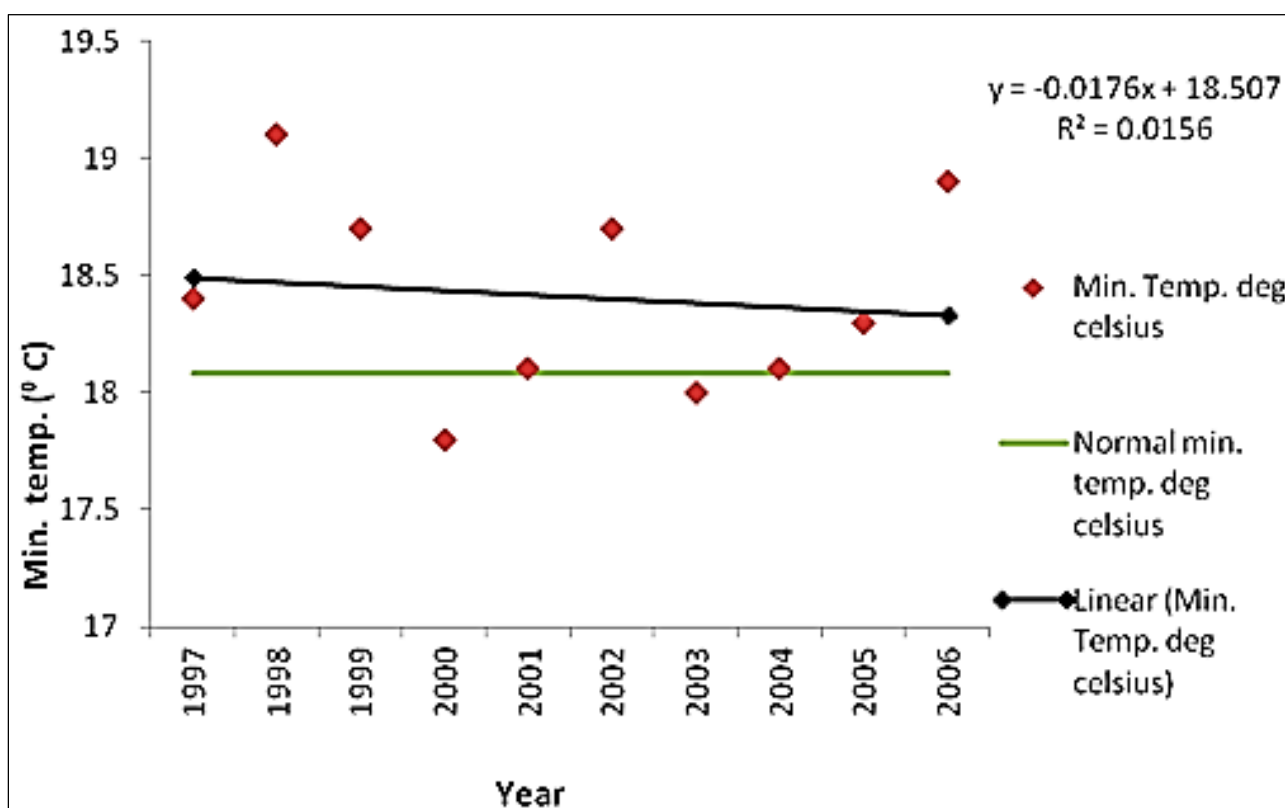


Fig 9: Decadal variation of average minimum temperature (1997-2006)

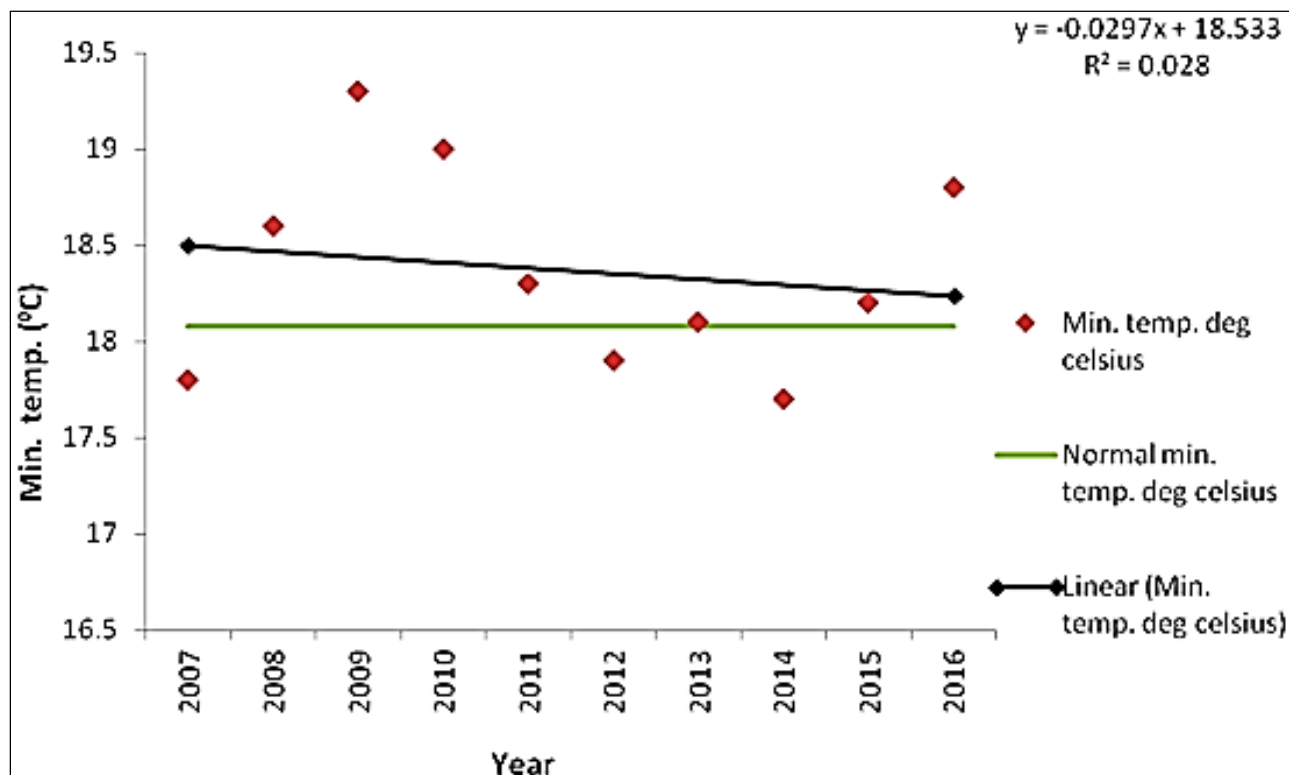


Fig 10: Decadal variation of average minimum temperature (2007-2016)

Conclusions

On the basis of results it may be concluded that annual rainfall variability of district Bahraich of U.P. gradually declined over the normal rainfall (1036.2mm) over last 30 years (1987-2016). After the year of 1997 rainfall decreasing trend found over normal rainfall. Annual variation of average maximum temperature, average minimum temperature and average temperature of district Bahraich of U.P. increased over normal 31.1 °C, 18.08 °C and 24.6 °C respectively over last 30years (1987-2016).

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