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Suraj Kumar
Department of Agricultural Meteorology, Achrya Narendra Deva University of Agriculture & Technology Kumarganj, Ayodhya, Uttar Pradesh, India

AN Mishra
Department of Agricultural Meteorology, Achrya Narendra Deva University of Agriculture & Technology Kumarganj, Ayodhya, Uttar Pradesh, India

AK Singh
Department of Agricultural Meteorology, Achrya Narendra Deva University of Agriculture & Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Alok Pandey
Department of Agricultural Meteorology, Achrya Narendra Deva University of Agriculture & Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Rakesh Kushwaha
Department of Agricultural Meteorology, Achrya Narendra Deva University of Agriculture & Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Corresponding Author:
AN Mishra
Department of Agricultural Meteorology, Achrya Narendra Deva University of Agriculture & Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Studies on the climatic variability analysis of Vindhyan Zone District Mirzapur of Eastern Uttar Pradesh

Suraj Kumar, AN Mishra, SR Mishra, AK Singh, Alok Pandey and Rakesh Kushwaha

Abstract
The historical data of weather parameters especially rainfall and temperature (maximum and minimum) of Vindhyan Zone of Eastern U.P. was collected for study from the period of 2000-2019. Climatic variability analysis was done on the basis of past historical data and result reveals in Vindhyan Zone (District Mirzapur) of U.P., the annual trend of rainfall have been studied using annual data series of 20 years (2000-2019). Data analyzed over last 20 years revel (2000-2019) that annual rainfall of Mirzapur gradually declined over the normal 993.0 (mm) in recent years. Annual average maximum temperature of Mirzapur of was found increasing trend over normal average maximum temperature (31.4^{0}C) during 20 years (2000-2019) period. Rise in average maximum temperature by 1.5^{0}C was found in the year 2018 over the normal temperature of district Mirzapur.

Keywords: Annual average rainfall, Annual average maximum and minimum temperature

Introduction
India is a largest country covering 3.28 million km^2, take only 2.4% of the world's geographical area. The country is situated north of the equator between 8°4' to 37°6' north latitude and 68°7' to 97°25' east longitude. It is the seventh-largest country in the word. But supporting 16.2 percent of the global bio-diversity and highly diverse ecology. Climate change in Intergovernmental Panel on Climate Change, (2007a) usage refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change, where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods. Globally, climate change poses significant risk across diverse ecosystem. In its sixth assessment report, the intergovernmental panel on climate change states that dry land region and population dependent on agriculture- based livelihoods are disproportionately at a higher risk to the climate variability. The increasing frequency of inter session variation in rainfall and temperature and other extreme events have significant impact on agriculture production and livelihoods particularly in India, where 60% of the total cropped is still rain-fed and large proportion of landholdings are small and fragmented. Recent 'warming of the climate system is unequivocal' (IPCC, 2007) [2] and the impacts of this warming are already being felt. However, they are not yet severe. There needs to be a balance between making policy too quickly and thus making the wrong decisions, while also following through on the need for anticipatory action (Burton *et al.* 2002)[1]. While the scientific knowledge of the impacts of human-induced climate change is not certain there are many places where present day climate variability and extremes are impeding development. One starting point is to assess and reduce people's vulnerability to today's climate while also taking into account how this relationship may change in the future. Agriculture is sensitive to short-term changes in weather and to seasonal, annual and longer-term variations in climate. For the long-term changes, agriculture is able to tolerate moderate variations in the climatic mean. The climate elements which affect the plant growth and development, hence the agriculture as a whole, are carbon dioxide concentration, temperature, radiation, precipitation and humidity.

Analysis of the food grains production/productivity data for the last few decades reveals a tremendous increase in yield, but it appears that negative impact of vagaries of monsoon has been large throughout the period. A number of questions need to be addressed as to determine the nature of variability of important weather events, particularly the rainfall received in a season/year as well its distribution within the season. These observations need to be coupled to management practices, which are tailored to the climate variability of the region, such as optimal time of sowing, level of pesticides and fertilizer application. The mean temperature in India is projected to increase by 0.1-0.3^{0}C in *kharif* and 0.3-0.7^{0}C during *rabi* by 2010 and by 0.4-2.0^{0}C during *kharif* and to 1.1-4.5^{0}C in *rabi* by 2070. Similarly, mean rainfall is projected not to change by 2010, but to increase by up to 10% during *Kharif* and *Rabi* by 2070. At the same time, there is an increased possibility of climate extremes, such as the timing of onset of monsoon, intensities and frequencies of drought and floods (S. A. Khan *et al.*, 2009) [5].

Material and Methods

An experiment was conducted during 2019 at the Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) on the topic entitled "Studies on the climatic variability analysis of Vindhyan Zone District Mirzapur of Eastern Uttar Pradesh" for past weather data of last 20 years (2000-2019) of Vindhyan Zone of Eastern Uttar Pradesh (Mirzapur) were collected from Banaras Hindu University (Varanasi) and district of Mirzapur. The collected data analyzed for observing the past trend of rainfall, maximum temperature (T_{max}) and minimum temperature (T_{min}). The demography of climate profile of study area and materials & methods employed during course of investigation has been described in following text;

Result

The rainfall data analyzed over the last 20 years 2000-2019 was divided into two decades 2000-2009 and 2010-2019, respectively which decades start the decreasing trend rainfall. It is given in table 1. First decade decrease over the normal rainfall in this decade the year 2001, 2002, 2003, 2004, 2005 and 2008 had the highest rainfall over the normal rainfall. In this decade the year 2010, 2011, 2013 and 2015 had the highest rainfall over the normal rainfall (mm) and minor decreasing over the normal rainfall (mm).

The average annual variation of maximum temperature is given in table 2. It can be observed that over the last 20 year (2000-2019). The average maximum temperature of Mirzapur district has increased over the normal average maximum temperature of 31.4ºC the highest average maximum temperature was in the year 2018 which was 32.9ºC while the lowest was 30.0ºC in the year 2006. From 2000 to 2019, there was major fluctuation of temperature, approximately between 31.4ºC to 32.9ºC. Thereafter, rise of average maximum temperature of about 1.5ºC was found during 2018. There was a large increasing trend of average maximum temperature found during 20 years (2000-2019). The average annual variation of minimum temperature is given in table 3 and shown in. It can be observed that over last 20 year (2000-2019). The average minimum temperature of Mirzapur district has slightly increasing over the normal average minimum temperature of 18.2 ºC the highest average minimum temperature was in the year 2019 which was 19.5ºC while the lowest was 15.0ºC in the year 2002. A slightly increases trend of 1.3ºC was found in average minimum temperature the year of 2019. The average temperature data analyzed over the last 20 years 2000-2019 was divided into two decades 2000-2009 and 2010-2019, respectively. The decadal variability of average temperature is given in table 4. A slightly increasing trend of minimum temperature was observed during this decade. Highest minimum temperature was in the years 2019 which was 26.2ºC while lowest minimum temperature was 24.6ºC in the year 2011. A slightly increasing trend of minimum temperature was observed during this decade.

Table 1: Annual rainfall (mm) variability of Vindhyan Zone (District Mirzapur)

Year	Rainfall(mm)
2000	1041.4
2001	1002.2
2002	1206.5
2003	1287.8
2004	1002.7
2005	1194.3
2006	786.3
2007	797.3
2008	1028.5
2009	911.1
2010	1055.6
2011	1140.8
2012	989.8
2013	1002.7
2014	855.4
2015	1015.5
2016	834.2
2017	980.6
2018	844.6
2019	883.3

Table 2: Annual average maximum temperature (^{0}C) of Vindhyan Zone (District Mirzapur)

Year	Temperature (^{0}C)
2000	30.8
2001	30.9
2002	31.8
2003	31.8
2004	30.6
2005	31.8
2006	30.0
2007	30.8
2008	31.3
2009	31.5
2010	31.1
2011	30.3
2012	30.9
2013	31.3
2014	31.0
2015	32.7
2016	31.2
2017	32.3
2018	32.9
2019	32.8

Table 3: Annual average Minimum temperature (^{0}C) of Vindhyan Zone (District Mirzapur)

Year	Temperature (^{0}C)
2000	18.5
2001	16.2
2002	15.0
2003	16.9
2004	18.4
2005	18.2
2006	17.6
2007	19.2
2008	18.3
2009	17.5
2010	18.9
2011	18.6
2012	18.3
2013	19.1
2014	18.7
2015	17.8
2016	18.1
2017	18.5
2018	18.7
2019	19.5

Table 4: Annual Variation of Average Temperature (^{0}C) of Vindhyan Zone (District Mirzapur)

Year	Temperature (^{0}C)
2000	24.7
2001	23.6
2002	23.4
2003	25.4
2004	24.5
2005	25.0
2006	23.8
2007	25.0
2008	24.8
2009	24.5
2010	25.0
2011	24.6
2012	24.6
2013	25.2
2014	24.9
2015	25.6
2016	24.7
2017	25.4
2018	25.8
2019	26.2

Conclusion

Annual rainfall variability of district Mirzapur of U.P. gradually declined over the normal rainfall (993.0 mm) over last 20 years (2000-2009). After the year of 2002 rainfall decreasing trend found over normal rainfall. Annual variation of average maximum temperature, average minimum temperature and average temperature of district Mirzapur of U.P. increased over normal 31.4^{0}C, 18.2^{0}C and 24.7^{0}C respectively over last 20 years (2000-2019). Moisture stress at terminal growth stages, undulated and major areas surrounded by rivers hence floods occurrence, lack of adequate irrigation facility due to irregular supply of electricity for making their alternative arrangement are identified major production constraints.

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