



ISSN (E): 2277- 7695

ISSN (P): 2349-8242

NAAS Rating: 5.03

TPI 2020; 9(9): 337-339

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www.thepharmajournal.com

Received: 29-06 -2020

Accepted: 15-08-2020

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

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Abstract

In district Sonbhadra of U.P., the annual trend of rainfall has been studied using annual data series of 20 years (2000-2019). Data analyzed over last 20 years (2000-2019) reveal that annual rainfall of Sonbhadra gradually declined over the normal 919.0 (mm) in recent years. Annual average maximum temperature of Mirzapur of was found increasing trend over normal average maximum temperature (31.3⁰C) during 20years (2000-2019) period. Rise in average maximum temperature by 1.5⁰C was found in the year 2019 over the normal temperature of district Sonbhadra. 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: Annual rainfall variability, Annual variation of average max. & min. temperature

Introduction

India is a largest country covering 3.28 million km², 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 of the world. But supporting 16.2 percent of the global biodiversity and highly diverse ecology. More than sixty percent of its population is dependent on climate sensitive activities such as agriculture. Climate change projections made up to 2100 century for India, Climate change and variability are concerns of human being. The recurrent droughts and floods threaten seriously the livelihood of billions of people who depend on land for most of their needs. The global economy is adversely being influenced very frequently due to extreme events such as droughts and floods, cold and heat waves, forest fires, landslips etc. The natural calamities like earth quakes, tsunamis and volcanic eruptions, though not related to weather disasters, may change chemical composition of the atmosphere. It will, in turn, lead to weather related disasters. 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, 3] 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 (DFID, 2004) while also taking into account how this relationship may change in the future. 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 0.1-0.3⁰C in *kharif* and 0.3-0.7⁰C during *rabi* by 2010 and by 0.4-2.0⁰C during *kharif* and to 1.1-4.5⁰C 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). Reported that the success or failure of rice crop for rainfed is closely linked with the rainfall pattern hence an understanding of the characteristics of rainfall and its distribution in relation to phenophases of the crop is a prerequisite for successful crop planning. In Eastern U.P. rainfall analyses revealed that rainfall is unevenly distributed and erratic. Rainfall data of period 1980-2000 of districts of eastern U.P. covering for July to September month were analyzed to decide the monsoonal activity, length of rainy season and variation and quantum of rainfall (Tripathi *et al.* 2007) [7]. Rainfall and temperature are the two most important driving factors for year-to-year variability in crop production and the available water resources. Stream flow is primarily driven by change in precipitation, which is intimately related to water availability. Furthermore, rainfed agriculture directly depends on the magnitude and temporal distribution of the rainfall (Milliman *et al.* 2008) [6].

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 Sonbhadra of Eastern Uttar Pradesh" of past weather data of last 20 years (2000-2019) of Vindhyan Zone of Eastern Uttar Pradesh (Sonbhadra) were collected from Banaras Hindu University (Varanasi) and district of Sonbhadra. 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

Data related to annual (January to December) rainfall variability (mm) of Sonbhadra district have been presented in table - 1 it can be observed from the data analyzed over last 20 years (2000-2019) that annual rainfall of Sonbhadra district has declined over the normal 919.6 mm. 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-2. Annual rainfall of Sonbhadra district has declined in the decade 2000-2009 over the normal rainfall of 919.6mm. First decade has found large decrease over the normal rainfall in this decade. The year 2001, 2002, 2004 and 2006 had the highest rainfall over the normal rainfall. Annual rainfall of Sonbhadra district has declined in the decade 2010-2019 over the normal rainfall of 919.6mm. In this decade the year 2011, 2012, 2013, 2014 and 2017 had the highest rainfall over the normal rainfall and minor decreasing over the normal rainfall (mm). The average annual variation of maximum temperature is given in table 3. It can be observed that over the last 20 year (2000-2019). The average maximum temperature of Sonbhadra district has increased over the normal average maximum temperature of 31.3°C the highest average

maximum temperature was in the year 2018 which was 32.8°C while the lowest was 30.2 °C in the year 2009. From 2000 to 2019, there was major fluctuation of temperature, approximately between 31.3°C to 32.8°C. Thereafter, rise of average maximum temperature of about 1.5°C was found during 2018. There was a large increasing trend of average maximum temperature found during 20 years (2000-2019). The average maximum 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 maximum temperature is given in table 4. The highest average maximum temperature was in the years 2008 which was 31.6°C while lowest average maximum temperature was 30.5°C. In the year 2006 A slightly increasing trend of average maximum temperature was observed during this decade. The highest average maximum temperature was in the years 2018 which was 32.8°C while lowest average maximum temperature was 30.4°C. In the year 2011 an increasing trend of average maximum temperature was observed during this decade. The average annual variation of minimum temperature is given in table 4.7 and shown in fig.19. It can be observed that over last 20 year (2000-2019). The average minimum temperature of Sonbhadra district has slightly increasing over the normal average minimum temperature of 18.9°C the highest average minimum temperature was in the year 2017 which was 20.1°C while the lowest was 17.3°C in the year 2006. A slightly increases trend of about 1.2°C was found in average minimum temperature the year of 2019. The average minimum 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 minimum temperature is given in table and highest average minimum temperature was in the year 2000 which was 18.9°C while lowest average minimum temperature was 15.3°C in the year 2006. A slightly increasing trend of average minimum temperature was observed during this decade. The highest average minimum temperature was in the years 2019 which was 20°C while lowest average minimum temperature was 18.7°C in the year 2010. A large increasing trend of average minimum temperature was observed during this decade. Average annual variation of temperature is given in table. It can be observed that over last 20 year (2000-2019) the average temperature of sonbhadra district has increased over the normal minimum temperature of 25.1°C the highest minimum temperature was in the year 2017 which was 26.4°C while the lowest was 23.9°C in the year 2006. A gradually increasing trend about 1.3°C was found in average 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 4.8 and it shown in fig. 23 for decade 2000-2009 and in fig. 24 for decade 2010-2019. Fig.23 shows that highest average temperature was in the year 2004 which was 25.2°C while lowest minimum temperature was 23.9°C in the year 2006. A slightly decreasing trend of minimum temperature was observed during this decade. Fig. 24 shows that highest minimum temperature was in the years 2019 which was 26.2°C while lowest minimum temperature was 24.8°C in the year 2011. A slightly increasing trend of minimum temperature was observed during this decade.

Table 1: Annual average temperature ($^{\circ}\text{C}$) of Vindhyan Zone (District Sonbhadra)

Years	Temperature $^{\circ}\text{C}$
2000	24.8
2001	24.7
2002	24.6
2003	24.4
2004	25.1
2005	24.8
2006	23.9
2007	24.9
2008	24.9
2009	24.5
2010	25.0
2011	24.8
2012	25.4
2013	25.65
2014	25.7
2015	24.9
2016	26.2
2017	26.4
2018	25.9
2019	26.2

Table 2: Annual average maximum temperature ($^{\circ}\text{C}$) of Vindhyan Zone (District Sonbhadra)

Year	Temperature($^{\circ}\text{C}$)
2000	30.7
2001	30.6
2002	31.5
2003	30.6
2004	31.5
2005	30.6
2006	30.5
2007	31.5
2008	31.6
2009	30.2
2010	31.3
2011	30.4
2012	31.9
2013	31.8
2014	30.6
2015	31.1
2016	32.3
2017	32.6
2018	32.8
2019	32.4

Table 3: Annual rainfall (mm) Variability of Vindhyan Zone (District Sonbhadra)

Year	Rainfall (mm)
2000	866.5
2001	1005.9
2002	1207.6
2003	768.0
2004	1030.7
2005	869.4
2006	1148.0
2007	687.3
2008	542.3
2009	739.4
2010	883.0
2011	836.0
2012	1011.2
2013	1050.2
2014	1026.6
2015	1000.3
2016	938.0
2017	960.0
2018	890.0
2019	930.9

Table 4: Annual average minimum temperature $^{\circ}\text{C}$ of Vindhyan Zone (District Sonbhadra)

Year	Temperature $^{\circ}\text{C}$
2000	18.9
2001	18.8
2002	17.6
2003	18.2
2004	18.8
2005	18.9
2006	17.3
2007	18.4
2008	18.2
2009	18.8
2010	18.7
2011	19.2
2012	18.9
2013	19.5
2014	19.7
2015	18.6
2016	20.0
2017	20.1
2018	19.0
2019	20.0

Conclusion

Annual rainfall variability of district Sonbhadra of U.P. gradually declined over the normal rainfall (919.60 mm) over last 20 years (2000-2019). After the year of 2006 rainfall decreasing trend found over normal rainfall. Annual variation of average maximum temperature, average minimum temperature and average temperature of district Sonbhadra of U.P. increased over normal 31.3°C , 18.9°C and 25.1°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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