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Impact of Climate Change on Characteristics of Rainfall and Temperature in Kamrup District of Assam

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Abstract*:* The North-East region receives heavy rainfall than other parts of India. It is one of the highest rainfall regions in India. Analysis of rainfall, temperature and flow pattern of the river across this region would be of great importance to water resources planners. The present work deals with the impacts of climate change in the rainfall pattern and changes in trend of temperature in the Kamrup District of Assam. Historical trends in rainfall, discharge and temperature is analysed for the past several years. Changes in rainfall pattern is presented showing changing trend in annual rainfall from 1901-2017.No significant trend of rainfall is observed but post 2000, the trend follows a declining trend of rainfall pattern. Similar analysis of temperature variation over the period 1901-2002 depicts almost a similar pattern between the year 1901 and 1997 and a rise in temperature in the beginning of 2000's. Trend of peak discharge in Brahmaputra river shows a declining pattern over the study period whereas the annual flow of the river shows a positive trend. The main aim of this study is to observe the flow pattern of Brahmaputra river gauged at Pandu station in Guwahati and to observe the rainfall pattern and the trend of temperature due to climate variation in the Kamrup District. The result is hoped can support the project design of water resources structures.

Keywords: Climate change, temperature, Rainfall pattern, discharge, Brahmaputra River

I. INTRODUCTION

Earth's climate is changing rapidly primarily as a result of human activities. Wide range of impacts due to global climate change has been experienced across every region of the country. According to IPCC, the effects of climate change on an individual region will vary with time and ability of various societal and environmental systems to mitigate or adapt to such changes. The global temperature is likely to increase further 1.5 to 1.9°C for lowest emission scenario and 3.4 to 6.1°C for their highest emission scenario in the 21st century. Climate change risk is now far greater than in 2005 because the impact of climate is very faster than expected. The major cause of climate change is Global Warming. Changes in concentrations of atmospheric gases like greenhouse gases and aerosols, land cover and solar radiation modify the energy balance of the climate system. The most important anthropogenic GHG is Carbon dioxide, CO_2. Global increases in CO_2 concentrations are primarily due to use of fossil fuel, with changes in the land-use pattern providing another significant but smaller contribution.

In NE region, whether rains will be in excess or deficient and when the fateful rainstorms will occur are determined chiefly by the state of the monsoon circulations of a particular year that follow an average pattern, but deviate to different extents very often under the possible impact of the global atmospheric forcing such as the ENSO. Excessive rainfall precipitated by the monsoon winds is the prime cause of floods in the region. Besides the years with normal and excess monsoon rainfall, the Northeast and adjoining region experience vigorous monsoon activities even amidst the large-scale failure of the monsoons over the Indian mainland due to its topography and the influence of the Himalayas leading to furious floods while the other parts of the country reel under disastrous droughts. Floods have thus become an assured phenomenon in the region every year. No conclusion could be drawn about the correlation of variability of rainfall and temperatures in the region. But it provides evidence that surface air temperatures are on the rise over the NE region and the rate of rise is higher than over some other regions of India. (P.J Das,2004).
The historical analysis of precipitation and temperature in the Brahmaputra basin revealed that there is a clear increasing trend in temperature at an average rate of 0.6 °C/100 year, with the largest increases in spring. No distinct drying or wetting trends are observed over the last 100 year and annual precipitation is primarily controlled by monsoon dynamics. The hydrological analysis showed that it is likely to assume that the majority of downstream stream flow in the Brahmaputra is generated by rainfall and to a much lesser extent by snow and glacial melt. (Immerzeel,2007)

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II. STUDY AREA

The type of climate of Assam is typically "tropical monsoon rainfall" with high levels of humidity and intense rainfall. Guwahati, one of the fastest growing cities in India, is situated on the south bank of Brahmaputra river. It is the largest city of Assam and North-East India, a major riverine port city. Most of the times, 2-3 hours of continuous heavy rainfall causes artificial flood in the city. In recent years, there has been a growing concern that the water resources of the river systems of Indus, Ganges and Brahmaputra is going to be vulnerable in the context of global climate change which could have considerable implications for the livelihoods and well-being of the people in the region.
The River Brahmaputra is the one of the mightiest rivers of Asia. The Brahmaputra river which flows across Assam is the fourth largest river in the world in terms of annual discharge. It is called Yarlung Tsangpo in Tibet. It originates from Angsi Glacier, on the northern side of the Himalayas. The total length of Brahmaputra River is 2906 km and the basin of the Brahmaputra river is 651334 km^2.The basin is of irregular form and the maximum east-west length is 1,540km and the maximum north-south width is 682 km. The basin lies between 23°N to 32°N latitude and 82°E to 97°50'E longitude. Its width increases in plains and becomes as wide as 10 km. The River has a drainage area of 240000 sq. km in Indian Territory. The Water Resources Department of Government of Assam has established two Gauge and Discharge observation sites- one at Pandu near Guwahati and the other at Bechamara which is now discontinued. River bed levels in Pandu near Guwahati is about 30m. The river has an average depth of 38 m (124 ft) and maximum depth 120 m (380 ft). The river is susceptible to catastrophic flooding in the spring when Himalayas snow melts. The average discharge of the river is about 19,800 m^3/s and floods is predicted to reach over 100,000 m^3/s. In this study, flood frequency analysis has been done for the river Brahmaputra gauged at Pandu station. The precipitation here is mainly due to South West monsoon. In the month of May to September heavy precipitation occurs here. If the flood of the tributaries coincides with the flood of Brahmaputra, it causes severe problem and destruction. The mean annual rainfall over the entire catchments including Tibet and Bhutan is about 2500 mm. The rainfall in Brahmaputra basin is mainly due to South-West monsoon and out of total annual rainfall, 85% occurs during the monsoon months from May to September. (Water Resources Department).

The average annual rainfall of 120 inches or more is experienced over Brahmaputra valley and surrounding area due to humidity that is brought here by the southwest monsoons. The climate of Assam has the characteristics of alternate cool and warm periods having high humidity especially from the month of May to November. Kamrup district of Assam is situated between 25˚46′ N to 26˚49′ N latitude and between 90˚48′ E to 91˚50′ E latitude. Its annual rainfall ranges between 1500 mm to 2600 mm. The summer maximum of 35 – 39 °C and a winter minimum of 5 – 8 °C). Assam receive high torrential rainfall of about 248cm-635cm which is also the cause of flooding of the Brahmaputra river.

Guwahati city of Assam has a humid subtropical climate. Rising temperature is one of the prime reasons of snow-melting at the Brahmaputra catchment. State level climate data for the period 1951-2010 has been analysed to observe the long-
term climate trends in Assam. This is done by the Indian Meteorological Department. The analysis in Assam is based on data collected from six stations for temperature and twelve stations for rainfall. From the analysis it has been observed that the mean temperature of the state has increased by +0.01°C/year. Also, it was seen that the annual rainfall shows a decrease in pattern by -2.96 mm/years during the same period. On an average, the number of rainy days is projected to decline but intensities would increase.

Rainfall variations summarised in INCCA Report, 2010
stated:
1. The mean annual rainfall is projected to increase in the region and found to vary from a minimum of 940±149 mm to 1330 ±174.5mm. .
2. Rate of increase in rainfall over Assam while projected to increase.
3. On an overall the number of rainy days is projected to decline in Assam, but intensities would increase.

III.DATA COLLECTION

1.Rainfall data from the website of Indian water portal and Indian Meteorological Department were collected for the period (1901-2017), i.e. for 117 years for the Kamrup District. By analysing the data, mean monthly peak rainfall data, annual rainfall data were found out and the historical trend is observed for the past 117 years.
2.Temperature data were taken from the website of Indian water portal for the period (1901-2002), i.e. for 102 years for the Kamrup District.
3.Discharge data of Brahmaputra basin gauged at Pandu station was collected from Water Resources Department, Lower Assam Investigation Division.

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IV.RESULTS AND ANALYSIS

Fig 1 depicts the annual rainfall distribution pattern for the period of 117 years (1901-2017) in the Kamrup District. Highest annual rainfall occurred in 1974 (5429.8 mm) while lowest annual rainfall occurred in 2006 (1188.8 mm). It can be observed that there is no significant trend of rainfall pattern in the year 1901 to 1975.The rainfall pattern is almost same in that period. Post 1975, there is a slight increase in rainfall and again follows the normal pattern of rainfall till 2002.After the year 2003, the graph shows a declining trend of rainfall pattern.

Fig 2, Fig 3, Fig 4 depicts the mean of average, maximum and minimum temperature respectively over the period 1901-2002.In all the cases, a similar pattern is observed between the year 1901 and 1997.There is a slight increase in temperature in the beginning of 2000's. However, it can be seen that, overall there is a gradual increase in temperature in the study period. From the Fig 5, it can be seen that the highest peak annual discharge of Brahmaputra river over the period (1987-2017) was in the year 1988 (61015 m^3/s) while lowest in the year 2006 (26377.36 m^3/s). No fixed trend or pattern can be seen. However, it can be observed that overall there is a gradual decrease in discharge during the study period. The average annual discharge in Brahmaputra river at Pandu gauge station follows almost a similar pattern and shows a rising trend across the year.

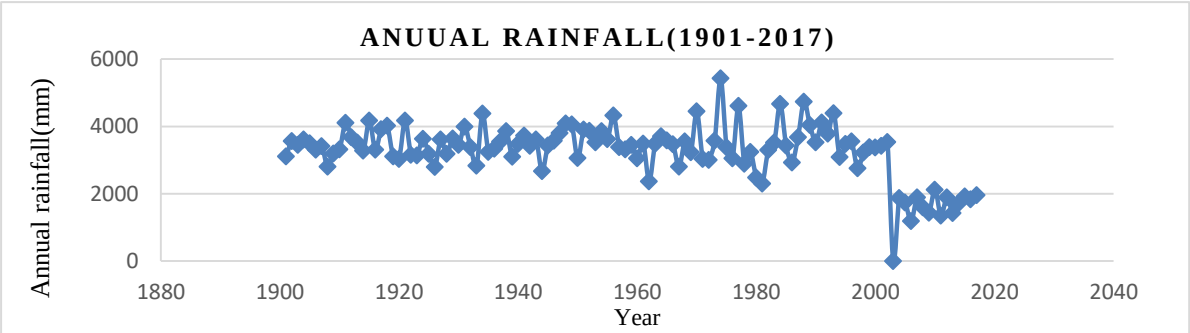

Fig1.Pattern of annual rainfall over the period 1901-2017 in Kamrup District

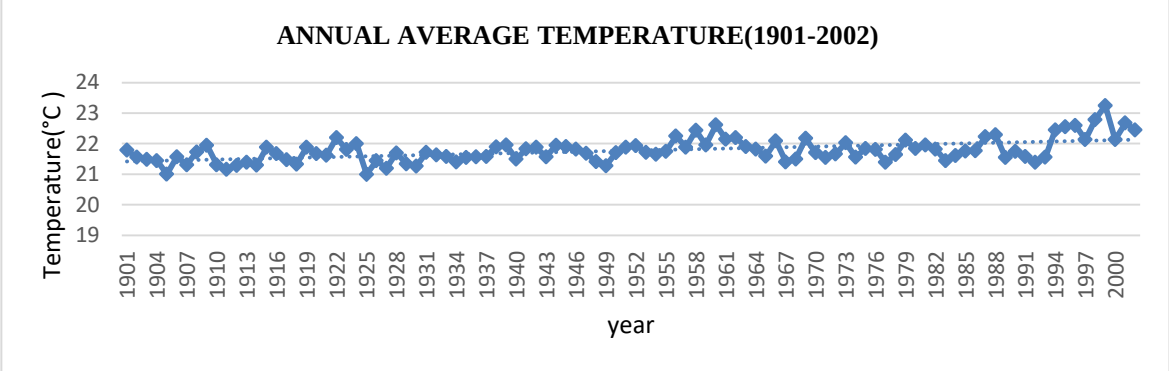

Fig 2. Annual average temperature during the period 1901-2002 in Kamrup District

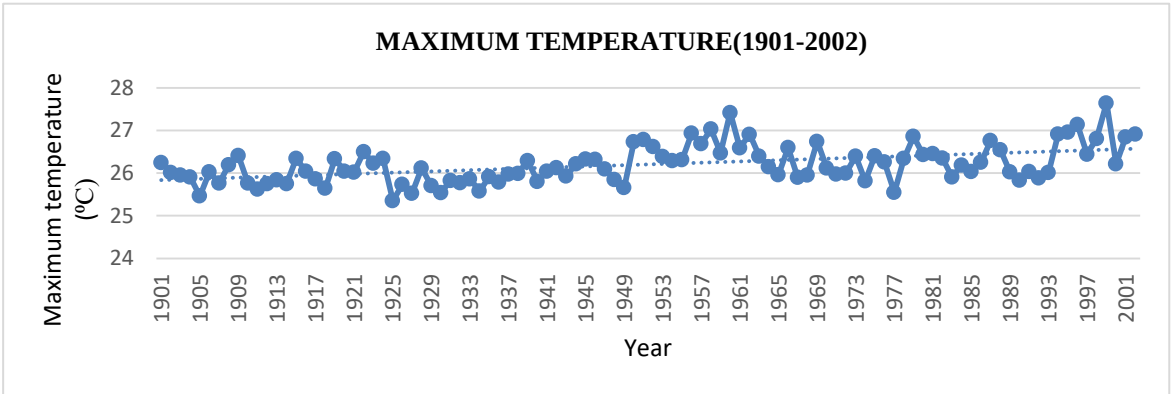

Fig 3. Maximum temperature during the period 1901-2002 in Kamrup District

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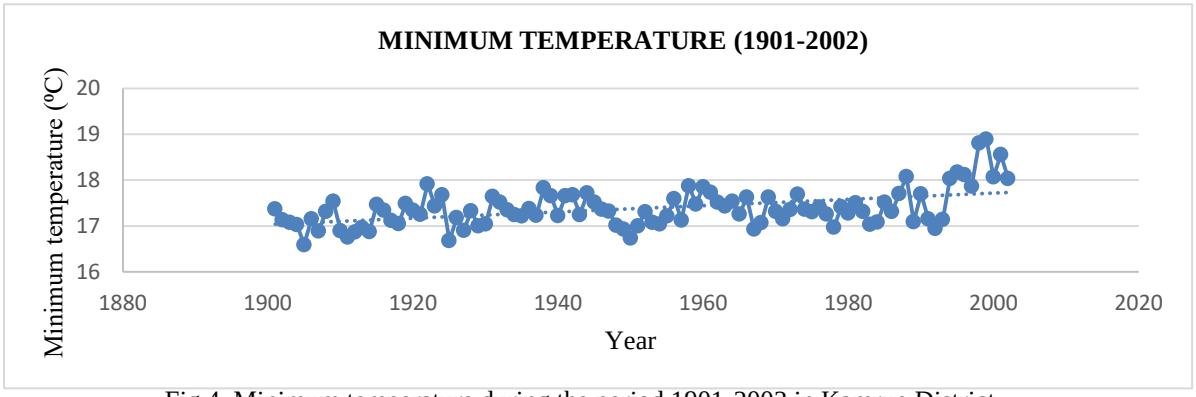

Fig 4. Minimum temperature during the period 1901-2002 in Kamrup District

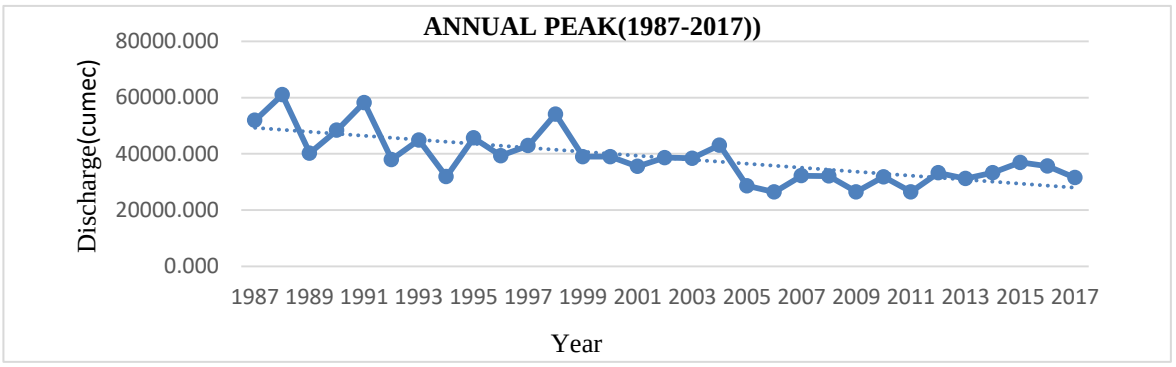

Fig 5. Annual peak discharge of river Brahmaputra at Pandu Gauge Station (1987-2017)

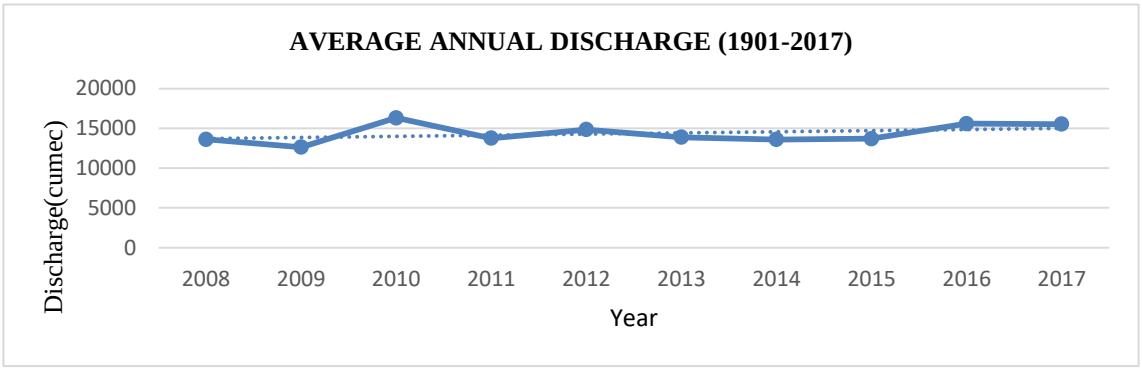

Fig 6. Average annual discharge in Brahmaputra river gauge station at Pandu (2008-2017)

V. CONCLUSION

In the present study, the discharge over Brahmaputra river, temperature and rainfall intensity in the Kamrup district have been analysed. To know the changes in morphology in a river, study of stream flow variation is very important. Therefore, the study focuses on the discharge variation over Brahmaputra river gauged at Pandu in Guwahati. From the analysis it can be concluded that the peak discharge in Brahmaputra river shows a declining trend over the study period. Since, the rainfall pattern shows a declining trend in the region, this may be one of the reasons for decrease in flow of the river across the years. Unlike the peak discharge of the river, the average annual discharge in the Brahmaputra river was found to follow a positive trend of flow during the study period.

By analysing the graph of annual rainfall, it can be concluded that overall there is a decrease in rainfall across the years with some fluctuations. There is no significant trend of rainfall pattern in the year 1901 to 1975.Post 1975, there is a slight increase in rainfall and again follows the normal pattern of rainfall till 2002.After the year 2003, the graph shows a declining trend of rainfall pattern. Also, it has been observed that the rainfall pattern from 1901-2002 shows almost a similar trend but after that, the rainfall pattern shows a decreasing trend.

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Further, the annual average temperature, minimum temperature and maximum temperature variation for the period 1901-2002 shows an increasing trend over the region. The pattern is almost similar till 1997 and after that shows a gradual rising trend. The results obtained in this study may help investigating the future scenario of discharge over the Brahmaputra basin, temperature and rainfall characteristics in the study region but more detailed and area specific study is still required.

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