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CLIMATE CHANGES AND RAINFALL VARIABILITY IN DISTRICT ETAWAH OF UTTAR PRADESH DURING LAST DECADE (2011 TO 2020)

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Abstract

The district Etawah of Uttar Pradesh is in the tropical monsoon zone and receives plenty of rainfall as most of the annual rainfall during the monsoon season every year. However, the rainfall is having high temporal and spatial variability and due to the impact of climate changes there are significant changes in the mean rainfall pattern and their variability as well as in the intensity and frequencies of extreme rainfall events. The result of the analysis based on the rent 10 years of data (2011-2020) on the mean local rainfall pattern as well as mean local pattern of different rainfall events, trends and variability as well as extreme rainfall events during the monsoon months and annual for the district Etawah of Uttar Pradesh state.

Key Words: *Rainfall trend, variability, extreme events, dry days.*

DISCUSSION AND RESULTS:

Data and Methodology : Daily Rainfall data from 2011 to 2020 is considered for analysis of trend, variability and mean rainfall patterns. From the daily rainfall data monthly rainfall series of each stations are computed and then monthly district rainfall series has been constructed by considering arithmetic average of all the station rainfall values within the district.. The monthly rainfall series of the district has been computed by using area weighted rainfall values within the district.

The objective of the analysis is to:

1. Identify the local pattern of the mean rainfall

2. Understand district wise observed rainfall trend and variability in annual and SW monsoon season (June, July, august and September). Daily station rainfall data is utilized for identification of the mean local patterns and rainfall intensity trends.

From mean and standard deviation (SD), the coefficient of variation (CV) is calculated as follows: Coefficient of variation (CV) = Standard Deviation/ Mean × 100

DISCUSSION AND RESULTS:

The State of Uttar Pradesh which is land locked state, situated between latitudes 23º87' N and 30º40' N and longitudes 77.08°' E and 84.63° E, has Uttarakhand and Himachal Pradesh on the northwest, Haryana and Delhi on the west, Rajasthan on the southwest, Madhya Pradesh on the south, Chhattisgarh and Jharkhand on southeast, Bihar on the east and Nepal on its northeast. The Himalayas provide the northern, Yamuna-the Western, the Ganga-the southern and Gandaki-the eastern boundary of the state.On the basis of its physical features, the state can be divided into following broad regions:

1. Sub-mountainous region
2. The Ganga Plain region and
3. The Trans-Yamuna region Climate of Uttar Pradesh is predominantly Sub-tropical monsoon, mild and dry winter and hot summer.The district Etawah is located in Gangatic plain region of Uttar Pradesh, With moisture-laden winds from the Arabian Sea, the Bay of Bengal and the Indian Ocean feeding bountiful rains over vast areas in central-north and northeast India, Western Ghats and peninsular India, central-eastern Himalayas; the summer monsoon activity is sustained through feedbacks between the monsoon circulation and the release of latent heat of condensation by moist convective processes.

THE NATURE OF INDIAN MONSOON: Monsoon is a familiar though a little known climatic phenomenon. Despite the observations spread over centuries, the monsoon continues to puzzle the scientists. Many attempts have been made to discover the exact nature and causation of monsoon, but so far, no single theory has been able to explain the monsoon fully. A real breakthrough has come recently when it was studied at the global rather than at regional level. Systematic studies of the causes of rainfall in the South Asian region help to understand the causes and salient features of the monsoon, particularly some of its important aspects, such as: (i) The onset of the monsoon. (ii) Rain-bearing systems and the relationship between their frequency and distribution of monsoon rainfall. (iii) Break in the monsoon.

Entry of Monsoon into India : The southwest monsoon sets in over the Kerala coast by 1st June and moves swiftly to reach Mumbai and Kolkata between 10th and 13th June. By mid July, southwest monsoon engulfs the entire subcontinent.

Rainfall : Winter monsoons do not cause rainfall as they move from land to the sea. It is because firstly, they have little humidity; and secondly, due to anti cyclonic circulation on

land, the possibility of rainfall from them reduces. So, most parts of India do not have rainfall in the winter season. However, there are some exceptions to it: (i) In northwestern India, some weak temperate cyclones from the Mediterranean sea cause rainfall in Punjab, Haryana, Delhi and western Uttar Pradesh. Although the amount is meagre, it is highly beneficial for rabi crops. The precipitation is in the form of snowfall in the lower Himalayas. It is this snow that sustains the flow of water in the Himalayan rivers during the summer months. The precipitation goes on decreasing from west to east in the plains and from north to south in the mountains. The average winter rainfall in Delhi is around 53 mm. In Punjab and Bihar, rainfall remains between 25 mm and 18 mm respectively. (ii) Central parts of India and northern parts of southern Peninsula also get winter rainfall occasionally. (iii) Arunachal Pradesh and Assam in the northeastern parts of India also have rains between 25 mm and 50 mm during these winter months. (iv) During October and November, northeast monsoon while crossing over the Bay of Bengal, picks up moisture and causes torrential rainfall over the Tamil Nadu coast, southern Andhra Pradesh, southeast Karnataka and southeast Kerala.

THE SOUTHWEST MONSOON SEASON: As a result of rapid increase of temperature in May over the northwestern plains, the low pressure conditions over there get further intensified. By early June, they are powerful enough to attract the trade winds of Southern Hemisphere coming from the Indian Ocean. These south east trade winds cross the equator and enter the Bay of Bengal and the Arabian Sea, only to be caught up in the air circulation over India. Passing over the equatorial warm currents, they bring with them moisture in abundance. After crossing the equator, they follow a southwesterly direction. That is why they are known as southwest monsoons. The rain in the southwest monsoon season begins rather abruptly.

Annual mean, maximum and minimum **temperatures** averaged over India during 2011–2020 show significant warming trend of 0.15 °C, 0.15 °C and 0.13 °C during the decade, respectively , which is consistent with dendro climatic studies. Pre-monsoon temperatures displayed the highest warming trend followed by post-monsoon and monsoon seasons. The frequency of warm extremes over the district has increased during 2011–2020, with accelerated warming trends during the recent 10 year period. Significant warming is observed for the warmest day, warmest night and coldest night since 2011.

The frequency and intensity of warm days and warm nights are projected to increase over India in the next decades, while that of cold days and cold nights is decreasing.

The pre-monsoon season heat wave frequency, duration, intensity and areal coverage over the district are projected to substantially increase during the mentioned decade.

It is observed that the district gets highest rainfall (34% of south west monsoon rainfall) in July month followed by August (31% of the south west monsoon rainfall). June and September receive 14% and 21% of south west monsoon rainfall, respectively. About 89% of annual rainfall receives during the southwest monsoon season only. The variability of monsoon and annual rainfall is 21% and 19%, respectively. Annual Mean 96.1 238.6 219.0 142.9 696.7 784.1 and CV 60.9 29.5 34.5 49.8 20.8 18.7 respectively is observed in the district for the months June, July, August and September. The minimum number of rainy days lies in the range of 22-26 days. In August, a significant increasing trend is observed in the district. Also the dry days are calculated in the range of 22-25 days during the decade. In southwest monsoon season, maximum number of dry days lies in the range of 83-88 days.

The district Etawah of Uttar Pradesh gets about 89% of its annual rainfall in the southwest monsoon season. The highest rainfall (34% of south west monsoon rainfall) is received in July month followed by August (31% of the south west monsoon rainfall). The southwest monsoon season rainfall and the annual rainfall show significant decreasing trends. September month rainfall has a significant decreasing trend, whereas other southwest monsoon months do not have any significant trend during the study period. The highest mean southwest monsoon rainfall (1117.5 mm) is observed over the district and the lowest mean southwest monsoon rainfall (420.8 mm) is observed.

In southwest monsoon, there is a significant increasing trend in the district. The annual average frequency of rainy days is maximum (~ 41-45 days) and minimum (~ 27-31 days). In the southwest monsoon, the maximum frequency of heavy rainfall days (~ 2.8-4 days) is observed and the minimum frequency of heavy rainfall days (~ 1-1.6 days) is observed. . The annual average frequency of heavy rainfall days is maximum (~ 3-4 days) in the same districts where it is maximum during the southwest monsoon, similarly it is minimum (~ 1-1.7 days) in the districts where it is minimum during the southwest monsoon season. The maximum number of dry days during the southwest monsoon season (~ 83.1-87 days) is observed. A significant decreasing trend in frequency of rainy days of southwest monsoon is

seen. In the southwest monsoon, a significant decreasing trend in the number of heavy rainfall days is seen in the district Etawah.

Climate over the district has varied significantly in the past decade in response to natural variations and anthropogenic forcing. In recent times, there has been considerable progress in understanding the influence of anthropogenic climate change over the district, particularly the regional monsoon. Yet, there remain substantial knowledge gaps with regard to climate projections, particularly at smaller local and temporal scales.

The changing patterns of rainfall in the district is responsible for depthening the water level in the district. The needs of irrigation are fully depended on underground water. This is responsible for low yielding of crops and increasing concentration of phosphates and sulphates in water. Agriculture is crucial for food, nutritional and livelihood security of people of the district. It engages almost seventy percent of the workforce in gainful employment and accounts for a significant share in national gross domestic product (GDP). Indian agriculture has made significant progress during the past decade. However, it is presently facing several challenges like stagnating net sown area, plateauing yield levels, deteriorating soil health, reducing per capita land availability etc. Additionally a new challenge is of vulnerability of agriculture to climate change.

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