

**Changes in Rainfall and Coefficient of Variability in The State of Uttar Pradesh : A
Geographical Analysis**

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Abstract

The economy of the whole world depends on agriculture. Agriculture is the main occupation of people in many countries including India, and agricultural income is mainly dependent on rainfall. Changes in the distribution of rainfall have been observed due to climate change. The study of rainfall is one of the most important factors in environmental studies, as groundwater levels, availability of drinking water, etc., depend on rainfall. The state of Uttar Pradesh is the most populous state in India. The distribution of rainfall in this state is uneven and the amount of rainfall varies over time.

Present paper reveals the analysis of average annual rainfall and changes in rainfall in the state of Uttar Pradesh from the year 1905 to 2015. The study also reveals the coefficient of variability of rainfall.

Keywords

Rainfall, Mean, Uttar Pradesh, Coefficient of Variability

Introduction

Regions with abundant rainfall have favorable climates for agricultural development as well as health and economic development. In such a region, the underground water level is not much deeper, but the lakes, reservoirs, rivers etc. in this region are always full, so the industries associated with it are also found to be developed in such regions. In short, the distribution of rainfall influences the development of a region more or less everywhere.

The state of Uttar Pradesh is a large state in the north-east of India. The amount of rainfall decreases from east to west in this state. Rainfall has a great contribution in the development of this state. In the present research paper, the distribution of rainfall and its changes during the period 1905 to 2015 have been studied in this state.

Objectives

The main objectives of the present research paper has follows,

- To study the actual and average annual (mean) rainfall distribution in Uttar Pradesh state during the period 1905 to 2015
- To discuss the decadal changes in mean rainfall of the study area
- To study the coefficient of variability of rainfall during 1905 to 2015

Data Source and Methodology

The data collected for the present study is of secondary nature. This information has been collected from 'Indian Meteorological Department', Lucknow. The analysis presented is based on data from decadal statistics. Actual annual rainfall and average rainfall are analyzed with the help of data for the years 1905, 1915, 1925, 1935, 1945, 1955, 1965, 1975, 1985, 1995, 2005 and 2015.

Mean rainfall and coefficient of variability is calculated with the help of following formula,

$$\text{Mean Rainfall} = \frac{\text{Total Yearly Rainfall}}{\text{Total Months}}$$
$$\text{CV} = \frac{\text{SD}}{\text{M}} \times 100$$

CV - Coefficient of variability, SD – Standard Deviation, M – Mean Rainfall

Collected and calculated values are shows in table, also distribution of rainfall and coefficient of variability is shown in graph.

Study Region

Uttar Pradesh is the North Eastern state of India and has the largest population in India. Uttar Pradesh has a total of 75 districts and according to the 2011 census, the total population is 199,812,341. About 16.50% of the population of India is in the state of Uttar Pradesh and the total population density per post in Uttar Pradesh is about 240,928. Sex ratio of total population in this state is 912.

Uttar Pradesh is situated between 23°52'N and 31°28'N latitudes and 77°3' and 84°39'E longitudes. Total area of the state is 243286 Sq.Km. and it is 7.33% of the geographical area of the country.

Actual Annual and Mean Rainfall (1905 to 2015)

Decade wise distribution of actual and man rainfall is shows in table no. 1.

Table No 1

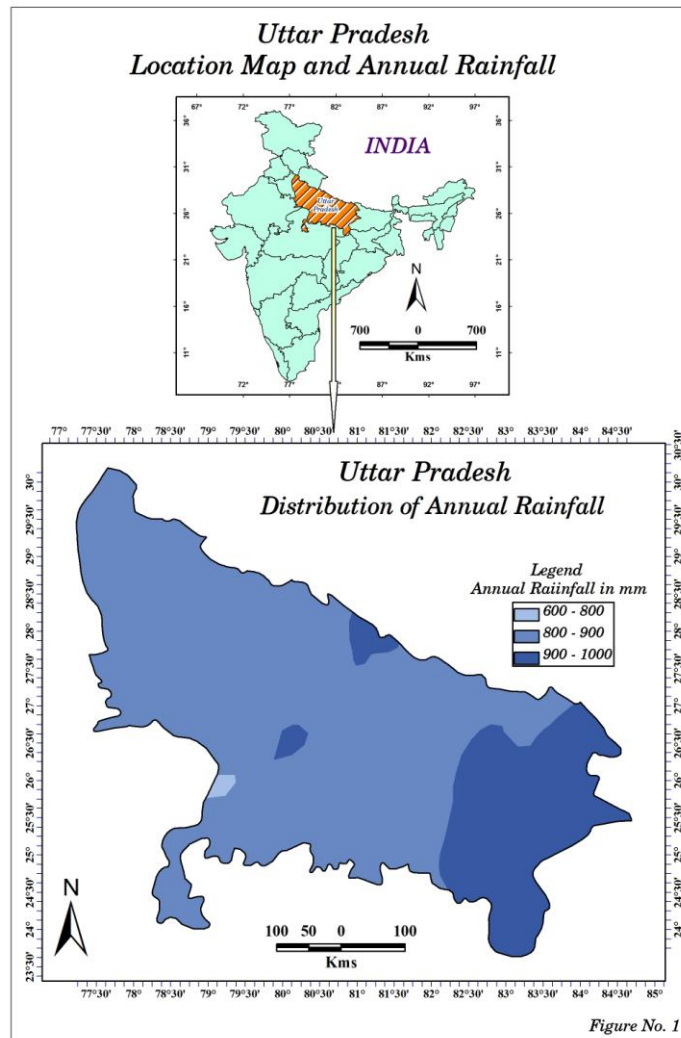
Uttar Pradesh – Actual and Mean Rainfall (1905 to 2015)

Rainfall in Millimeter		
Year	Actual Annual Rainfall	Mean Rainfall
1905	1325.10	110.43
1915	2212.30	184.36
1925	2057.90	171.49
1935	1704.40	142.03
1945	1946.40	162.20
1955	2485.20	207.10
1965	1359	113.25
1975	2215	184.58
1985	2133.10	177.76
1995	1687.30	140.61
2005	1496	124.67
2015	1186	98.83

Source – Regional Metrological Department, Lucknow

The distribution of rainfall in the state of Uttar Pradesh has fluctuated greatly between 1905 and 2015. During the period from 1905 to 2015, the amount of rainfall is not the same in any decade but there is a variation in it. The highest rainfall in the state of Uttar Pradesh was in the year 1955. This year the annual rainfall was about 2485.2 mm while the average was 207.10 mm. In the year 1955, there was an increase in rainfall compared to the previous decade, but in the following decade, there is a decrease.

The lowest annual rainfall in the state of Uttar Pradesh was recorded in the recent period i.e. in the year 2015. This year only 1186 mm of annual rainfall was recorded while the annual average was 98.93 mm.



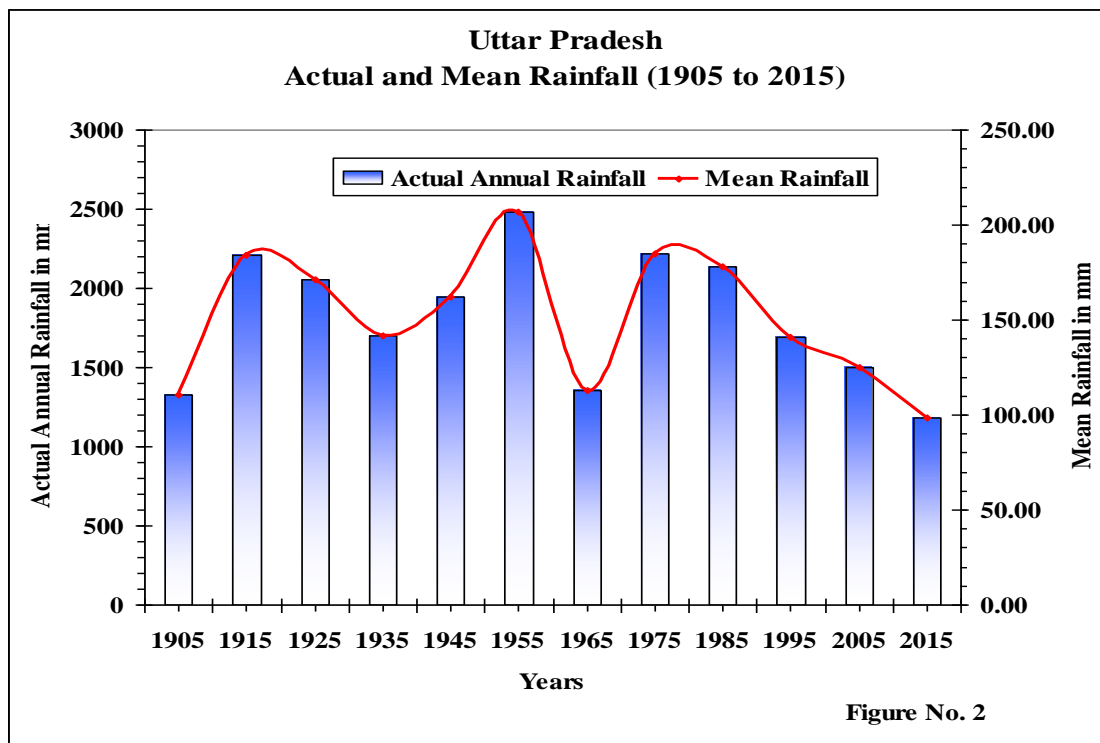
In the years 1915 (2212.30 mm), 1925 (2057.90 mm), 1955 (2485.20 mm), 1975 (2215 mm) and 1985 (2133.10 mm), the state received a total rainfall of more than 2000 mm. Whereas the annual average rainfall is more than 170 mm.

In all other periods the annual rainfall ranges between 1100 and 2000 mm. But except for the year 2015, the average annual rainfall was more than 110 mm.

The two months of July and August record the highest rainfall in the study area. Generally, the state receives more than 550 mm of rainfall in July and August together.

Although the state receives satisfactory rainfall, the rainfall is less compared to the area of the state.

Figure no.2 shows the variation of actual annual and mean rainfall in the state from the year 1905 to 2015.



Changes in Mean Rainfall (1905 to 2015)

Overall, the average annual rainfall has decreased in the state of Uttar Pradesh. There is a significant difference in rainfall between 1905 and 2015. In the year 2015, the average annual rainfall has decreased by 11.60 mm compared to 1905. The decadal changes in mean rainfall of the state is shown in table no. 2

Table No. 2

Uttar Pradesh – Decadal Changes in Mean Rainfall (1905 to 2015)

Period	Changes in Mean Rainfall (mm)
1905 to 1915	+73.93
1915 to 1925	-12.87
1925 to 1935	-29.46
1935 to 1945	+20.17
1945 to 1955	+44.90
1955 to 1965	-93.85
1965 to 1975	+71.33
1975 to 1985	-6.83
1985 to 1995	-37.15
1995 to 2005	-15.94
2005 to 2015	-25.83

Source – Calculated by Author

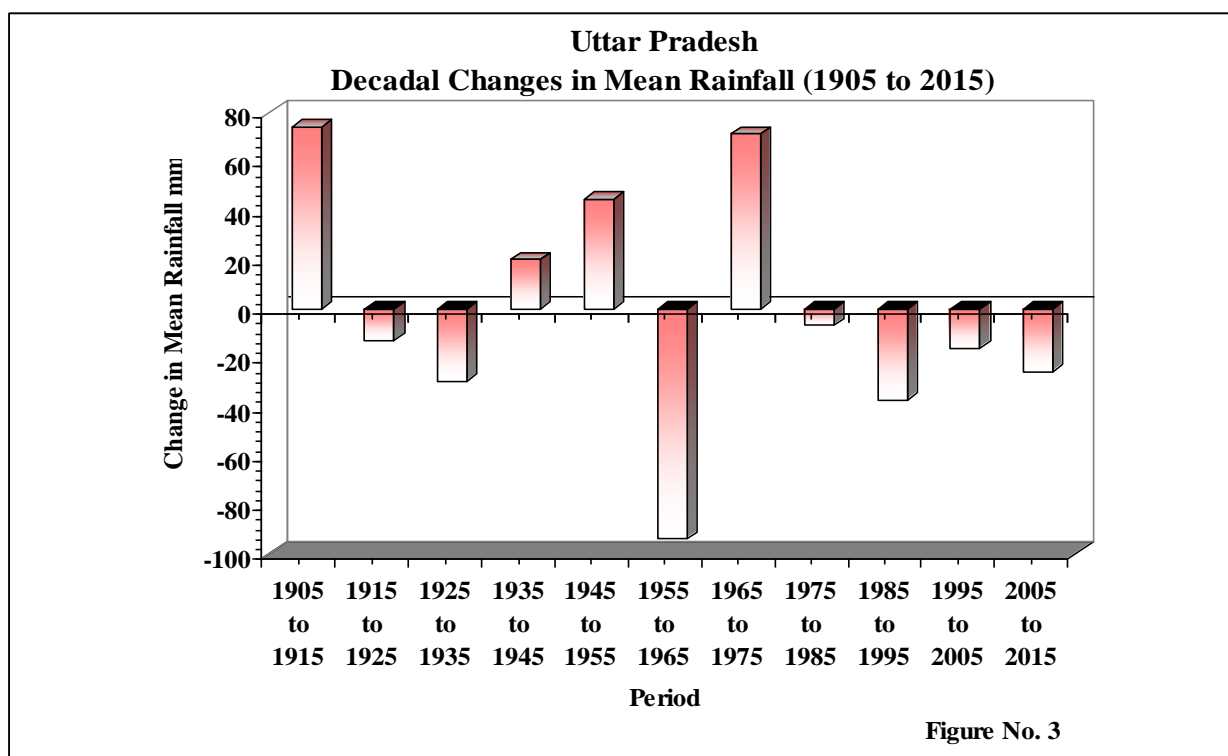
Positive Changes in Mean Rainfall

The average annual rainfall in the state of Uttar Pradesh has increased during the decades 1905 to 1915 (73.93 mm), 1935 to 1945 (20.17 mm), 1945 to 1955 (44.90 mm) and 1965 to 1975 (71.33 mm). The highest increase in average rainfall is 73.93 mm during 1905 to 1915, while the lowest increase is 20.17 mm during 1935 to 1945.

Negative Changes in Mean Rainfall

Except for the year of positive changes, the mean rainfall has decreased in all the other decades. The average annual rainfall has decreased continuously in the twenty years from 1915 to 1935 and in the forty years from 1975 to 2015. Pollution and deforestation due to increasing population is a major factor in the decrease in rainfall.

Figure no. 3 shows the decade wise changes in mean rainfall in Uttar Pradesh



Coefficient of Variability of Rainfall (1905 to 2015)

Decadal coefficient of variability in Uttar Pradesh state is shown in table no. 3, table also shows the mean between two decades and standard deviation of rainfall.

If we look at the total average of the year 1905 to 2015 in the state of Uttar Pradesh, it is 1817.31 mm which is very less compared to the year 110. The standard

deviation of the period from 1905 to 2015 is 417.60 while the coefficient of variability is 22.98%. There are many fluctuations in the rainfall in the state. Between 1905 and 1915 there was a sharp increase, while between 1955 and 1965 there was a sharp decrease. That is why there is a difference in the coefficient of availability.

Table No. 3

Uttar Pradesh – Coefficient of Variability (CV) (1905 to 2015)

Period	Mean Rainfall (mm)	SD	CV
1905 to 1915	1768.70	627.35	35.47
1915 to 1925	2135.10	109.18	5.11
1925 to 1935	1881.15	249.96	13.29
1935 to 1945	1825.40	171.12	9.37
1945 to 1955	2215.80	380.99	17.19
1955 to 1965	1922.10	796.34	41.43
1965 to 1975	1787.00	605.28	33.87
1975 to 1985	2174.05	57.91	2.66
1985 to 1995	1910.20	315.23	16.50
1995 to 2005	1591.65	135.27	8.50
2005 to 2015	1341.00	219.20	16.35
Total 1905 to 2015	1817.31	417.60	22.98

Source Calculated by Author

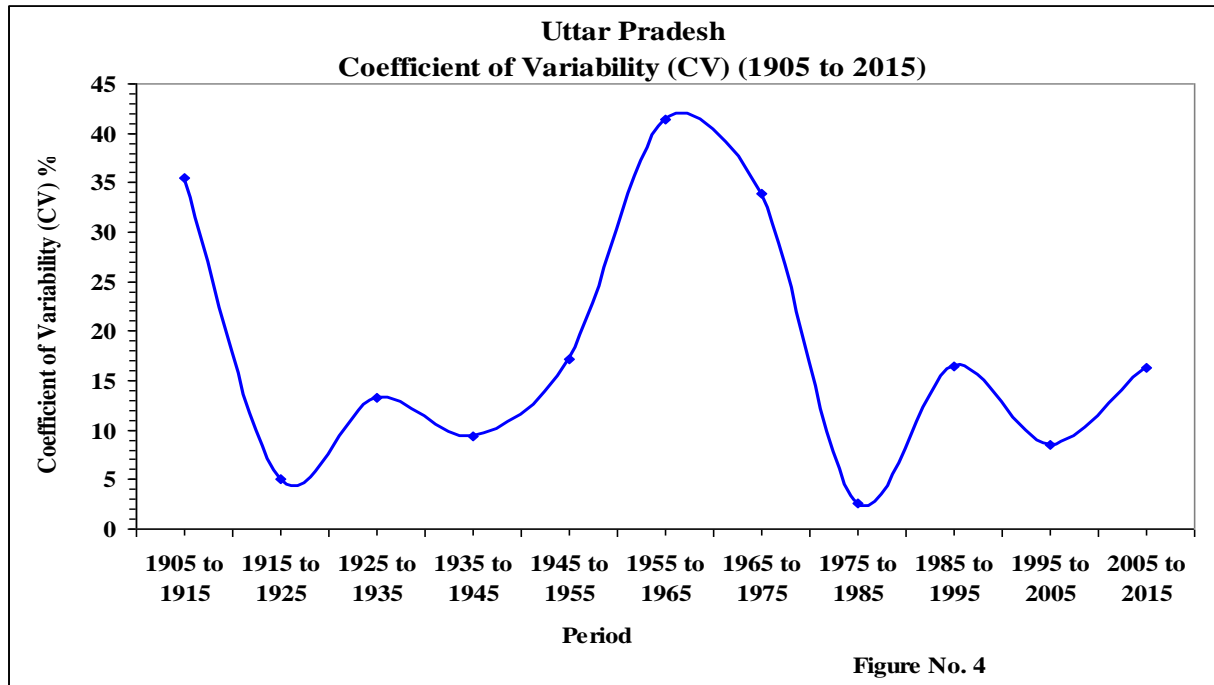
The coefficient of variability in the state was highest at 41.43% during the years 1955 to 1965, as this period saw the highest variation in rainfall in two decades. After this, the coefficient of availability was 35.47% during 1905 to 1915 and 33.87% during 1965 to 1975. Between 1905 and 1915 the average annual rainfall increased by 73.93 mm, while between 1965 and 1975 it increased by 71.33 mm. The increase was the highest, with precipitation decreasing in 1965 compared to 1955, but increasing again in 1975. Due to such variation the coefficient of availability increased during this period.

In the study area, the lowest coefficient of variability was 2.66% during the period 1975 to 1985 because there was a large gap between the average rainfall and the standard deviation during this period. Compared to the average rainfall, the value of standard deviation was very low and the amount of rainfall was also reduced during those ten

years.

Coefficient of availability in the state was less than 10% during 1915 to 1925, 1935 to 1945, 1975 to 1985 and 1995 to 2005 while in other decades it ranged from 10 to 18%.

Figure no. 4 shows the coefficient of variability of rainfall in study area from 1905 to 2015.



Conclusions and Suggestions

The rainfall in Uttar Pradesh state has been moderate in the last 11 decades, but considering the growing population of Uttar Pradesh state, the rainfall is low. Also, the decrease in rainfall in 2015 is a matter of concern.

From the year 1905 to 2015, there was a decrease in rainfall, while in some periods there was a sudden increase. Due to this variation and uncertainty was seen in the coefficient of availability. The state of Uttar Pradesh mainly receives more rainfall in the east as this region is close to the Bay of Bengal. In the east, the amount has decreased.

The demand for natural resources is highest in the state of Uttar Pradesh due to its population distribution. Therefore, the amount of natural vegetation in this state has decreased in the past few years. This has a direct effect on the rainfall in the state.

Illegal felling of forests must be stopped for abundant rainfall. Also increasing the quantity of natural plants is the need of the hour. It is also necessary to increase the green cover in the open spaces of the state; similarly, it is necessary to clear the silt in the lake

from time to time and to increase the width of the reservoirs. This will increase the evapotranspiration in such a place without soil erosion and thus help increase the amount of rainfall.

Only if the environment is protected, the balance of nature will be maintained and there will be abundant rain for the overall development of agriculture and human beings of the state of Uttar Pradesh.

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