Observed Rainfall Variability and Changes over Haryana State

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Abstract

India 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 report brings the result of the analysis based on the recent 30 years of data (1989-2018) on the mean spatial rainfall pattern as well as mean spatial pattern of different rainfall events, trends and variability as well as extreme rainfall events during the monsoon months and annual for the state.
1. **Introduction**

The State Haryana which roughly lies in the area bounded by 27°39', 31°N latitudes and 74°31', 77°30'E longitudes forms the eastern part of the table land between the Sutlej and the Jamuna the south of the former river and to north of Rajasthan desert. The state has the Jamuna on its eastern border and on the north Himachal Pradesh, while it adjoins Rajasthan desert on south and southwest and Punjab on the northwest. There are three main physical divisions in the state namely, the Himalayan submountane areas which stretches from the Jamuna to the Salt Range, the arid South-western plains and the western portion of the Indo-Gangetic Plain that constitutes the central portion of the state. The whole of Haryana consists of a vast alluvial plain except in the northeast region which falls under Himalayan submontain region. There is no other mountain system of importance in the state but a few unimportant outliers the Aravali system pass of across Gurgaon District in the extreme southeast and terminate in the Ridge at Delhi.

The slope of the low country is to the south and southwest, and is Jamuna, is the only river of the state, which ultimately drains into the Bay of Bengal, rises in Tehri district of Uttar Pradesh, very gradual and forms its junction with the Tons at the eastern extremity of Sirmaur district of Himachal Pradesh forms the boundary between Haryana and Uttar Pradesh for a distance of over 320 kilometres.

The most important perennial irrigation canal in Haryana is the Western Jamuna Canal which originates from the west bank of the Jamuna and irrigates almost all the districts of Haryana. The state is practically free from maritime influence. Orographic feature and absence of maritime influence affect to a large extent the climate of the state. The state experiences an extreme type of climate.

There are many studies available on the observed trends and variability of rainfall and extreme rainfall events, but all the studies are based on past 100 years or more data and also the recent years are not included (Malik & Singh, 2019; Guhathakurta et al, 2015; Guhathakurta et al, 2011; Guhathakurta & Rajeevan, 2008 etc). In the present report all the analysis of observed rainfall patterns, trends and variability have been done based on recent past 30 years (1989-2018) that will help to have idea of the recent changes for climate change adaptation and management by the state authorities.

2. **Data and Methodology**

Daily Rainfall data from 1989 to 2018 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 state has been computed by using area weighted rainfall values of all the districts within the state. The objective of the analysis is to:

1. Identify the spatial 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 spatial patterns and rainfall intensity trends. From mean and standard deviation (SD), the coefficient of variation (CV) is calculated as follows:

\[
\text{Coefficient of variation (CV)} = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100
\]

The analysis has been done in two parts. For identification of the spatial pattern mean rainfall and variability and observed trends we have used district rainfall series and results have been brought out for four southwest monsoon months viz. June, July, August, September, for the southwest monsoon season and for annual. Fig.1 gives the location of the districts of the state. For identification of mean pattern and trends of intensities of various rainfall events we used the station daily rainfall data.

![Fig. 1 Location of the districts of Haryana](image)

### 3. State rainfall mean and variability trend

Table 1 shows the mean rainfall (mm) and coefficient of variation of the state for the monsoon months, southwest monsoon season and annual during the period 1989-2018. It can be seen that the state gets highest rainfall (33%) of south west monsoon rainfall in August month while the July month get 32% of the south west monsoon rainfall. June and September receive 14% and 21% of south west
monsoon rainfall. Also more than 82% of annual rainfall receives during the southwest monsoon season only. The variability of monsoon or annual rainfall is 31% and 27% respectively.

<table>
<thead>
<tr>
<th>Monsoon Months</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>JIAS</th>
<th>Annual</th>
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</thead>
<tbody>
<tr>
<td>Mean</td>
<td>57.7</td>
<td>130.9</td>
<td>137.5</td>
<td>84.5</td>
<td>410.6</td>
<td>499.7</td>
</tr>
<tr>
<td>CV</td>
<td>70.6</td>
<td>52.7</td>
<td>58.4</td>
<td>64.8</td>
<td>31.0</td>
<td>27.2</td>
</tr>
</tbody>
</table>

Table 1 Mean rainfall (mm) and coefficient of variation of the state for the monsoon months, southwest monsoon season and annual

Fig. 2 and 3 show the time series of rainfall in mm for the months of June, July, August, September and southwest monsoon season, annual respectively. The trend lines are also displayed for each of the series. Seasonal and annual rainfall shows decreasing trend. In the monthly rainfall June show increasing trend while July, August and September rainfall show decreasing trend. However, neither monthly nor seasonal/annual trend is significant statistically. During the last 30 years highest rainfall of June and July received in the year 2008 and 1994 (201.4 mm and 280.5 mm respectively) while highest rainfall of 401.2 mm in August received in the year 1995 and of 181.4 mm in September received in the year 1990. Highest annual rainfall of 840.6 mm and highest southwest monsoon rainfall of 754.1 mm received in the year 1995.

![Haryana State monsoon month rainfall](image)

Fig. 2 Time series of rainfall in mm for the months of June, July, August, September and trends
4. District rainfall mean, variability and trend

4.1 Mean and coefficient of variation

Table 2 gives the rainfall statistics for the districts of Haryana for the four monsoon months, southwest monsoon season and annual while Fig.4-5 show the spatial pattern of these statistics. It can be seen that three districts viz. Yamunanagar, Panchkula and Ambala receive highest rainfall over other districts during all the months and season. Rainfall receives over these districts are around 90-130 mm in June, 260-320mm in July, 260-300mm in August, 140-160mm in September and during the SW monsoon and annual 790-890mm. Lowest rainfall receives during the SW monsoon season over Sirsa district (218.5mm) while Fatehabad district receives lowest annual rainfall (311.0mm).

<table>
<thead>
<tr>
<th>DISTRICT</th>
<th>JUNE</th>
<th>JULY</th>
<th>AUGUST</th>
<th>SEPTEMBER</th>
<th>MONSOON</th>
<th>ANNUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MEAN</td>
<td>CV</td>
<td>MEAN</td>
<td>CV</td>
<td>MEAN</td>
<td>CV</td>
</tr>
<tr>
<td>Ambala</td>
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<td>59.0</td>
<td>274.7</td>
<td>51.5</td>
<td>265.3</td>
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<td>Gurgaon</td>
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<td>66.1</td>
<td>166.5</td>
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<td>91.9</td>
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<td>85.9</td>
<td>73.3</td>
</tr>
<tr>
<td>Jind</td>
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<td>79.6</td>
<td>116.4</td>
<td>64.6</td>
<td>125.7</td>
<td>65.1</td>
</tr>
<tr>
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<td>66.5</td>
<td>142.8</td>
<td>65.2</td>
<td>142.8</td>
<td>57.2</td>
</tr>
<tr>
<td>District</td>
<td>3</td>
<td>7</td>
<td>12</td>
<td>25</td>
<td>60</td>
<td>118</td>
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<td>----</td>
<td>----</td>
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</tr>
<tr>
<td>Mahendragarh</td>
<td>67.4</td>
<td>123.8</td>
<td>125.8</td>
<td>60.1</td>
<td>118.1</td>
<td>76.9</td>
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<td>132.7</td>
<td>70.8</td>
<td>178.1</td>
<td>81.4</td>
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<tr>
<td>Rohtak</td>
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<td>105.7</td>
<td>69.5</td>
<td>131.4</td>
<td>74.8</td>
</tr>
<tr>
<td>Bhiwani</td>
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<td>102.1</td>
<td>70.3</td>
<td>114.7</td>
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<td>65.6</td>
<td>192.5</td>
<td>56.1</td>
</tr>
<tr>
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<td>115.1</td>
<td>71.5</td>
<td>131.1</td>
<td>87.4</td>
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<td>71.1</td>
<td>77.3</td>
<td>59.5</td>
<td>95.4</td>
</tr>
<tr>
<td>Sonepat</td>
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<td>80.2</td>
<td>141.7</td>
<td>64.4</td>
<td>159.7</td>
<td>74.0</td>
</tr>
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<td>Yamunanagar</td>
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<td>81.5</td>
<td>316.6</td>
<td>41.7</td>
<td>297.9</td>
<td>57.3</td>
</tr>
<tr>
<td>Kaithal</td>
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<td>91.2</td>
<td>134.2</td>
<td>122.6</td>
<td>123.0</td>
<td>77.1</td>
</tr>
<tr>
<td>Panipat</td>
<td>54.3</td>
<td>76.7</td>
<td>116.3</td>
<td>71.6</td>
<td>137.5</td>
<td>75.3</td>
</tr>
<tr>
<td>Rewari</td>
<td>60.4</td>
<td>81.0</td>
<td>152.1</td>
<td>55.6</td>
<td>147.4</td>
<td>72.4</td>
</tr>
<tr>
<td>Panchkula</td>
<td>95.3</td>
<td>101.7</td>
<td>264.5</td>
<td>61.4</td>
<td>293.5</td>
<td>52.3</td>
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<tr>
<td>Fatehabad</td>
<td>39.5</td>
<td>66.3</td>
<td>77.0</td>
<td>78.3</td>
<td>71.0</td>
<td>91.2</td>
</tr>
<tr>
<td>Jhajjar</td>
<td>36.9</td>
<td>107.0</td>
<td>112.2</td>
<td>75.3</td>
<td>122.9</td>
<td>69.4</td>
</tr>
<tr>
<td>Palwal</td>
<td>30.4</td>
<td>94.8</td>
<td>125.5</td>
<td>62.8</td>
<td>160.4</td>
<td>65.9</td>
</tr>
</tbody>
</table>

Table 2. Rainfall statistics for the districts of Haryana for the four monsoon months, southwest monsoon season and annual

![State Haryana Average Rainfall in mm - June](image1)

![State Haryana Average Rainfall in mm - July](image2)
Fig. 4 Mean rainfall pattern over districts of Haryana
4.2 Trend in district rainfall

Fig. 6 shows the trends in district rainfall for (a) June, (b) July (c) August (d) September (e) JJAS and (f) annual. It can be seen that June month’s rainfall has shown decreasing trend in four districts namely Fatehabad, Panipat, Panchkula, Gurgaon while rest of the districts has shown increasing trend. However the trends are not significant. In July rainfall, significantly decreasing trend has been noticed in three districts namely Sirsa, Kaithal, Panchkula. Faridabad, Palwal has shown increasing trend while rest of state has decreasing trend but these trends are not significant. In August rainfall three districts viz. Panipat, Kaithal, Panchkula has significantly decreasing trend. In September rainfall only Panchkula district is having significantly decreasing trend. During the whole southwest monsoon season only six districts viz. Panchkula, Ambala, Kaithal, Panipat, Bhiwani, Charkhi Dadri has shown significant decreasing trend and rest of state has non-significantly decreasing trend. For the annual rainfall three districts viz. Ambala, Panchkula and Panipat show significant decreasing trend while rest of districts showed non-significantly decreasing trend.
Fig.6 Trends in district rainfall for (a) June, (b) July (c) August (d) September (e) JJAS and (f) annual
5. **Analysis of Average frequencies for rainfall events of different intensities**

5.1 **Average frequency of Rainy days**

The average frequency of rainy days is calculated for Haryana for June, July, August, September, June to September and Annual and are shown in Figure 7-12.

In the month of June the maximum number of rainy days lies in the range of 5 to 6 days especially in North Eastern districts of Haryana. While minimum number of rainy days lies in the range of 2 to 3 days especially in South eastern districts. Whereas in remaining districts, the number of rainy days lies in the range of 3 to 5 days.

In the month of July the maximum number of rainy days lies in the range of 9 to 11 days especially in upper North Eastern districts of state as we move to southward rain days frequency reduces to 8. While minimum number of rainy days lies in the range of 4 to 6 days especially in north western districts while central parts of state have 6 to 8 days of rainy days (Figure 9).

During August the maximum number of rainy days lies in the range of 10 to 12 days especially in North and north eastern districts. As we move from north to south (eastward) number of rainy days reduces gradually to 7 days. While central districts have number of rainy days in range of 6 to 7 days. Minimum number of rainy days lies in the range of 4 to 6 days especially in northwestern districts.

In the month of September the maximum number of rainy days lies in the range of 5 to 6 days especially in north eastern districts of state. Eastern districts of states have rainy days ranging between 4 to 5 days with some patches of higher rainy days in south. While minimum number of rainy days lies in the range of 2 to 3 days especially in northwestern district. Whereas in remaining central districts, the number of rainy days lies in the range of 3 to 4 days.

During June to September the maximum number of rainy days lies in the range of 28 to 32 days especially in North Eastern districts. While minimum number of rainy days lies in the range of 14 to 18 days especially in North Western Districts. Whereas in remaining central districts, the number of rainy days lies in the range of 18 to 21 days while southern and eastern districts have rainy days in range 21 to 25 days.
During the entire year the maximum number of rainy days lies in the range of 38 to 43 days especially in north eastern districts of state. While minimum number of rainy days lies in the range of 20 to 24 days especially in north western districts. Whereas in remaining districts, the number of rainy days lies in the range of 24 to 38 days.
5.2 Average frequency of Heavy rainfall days

The average frequency of Heavy rainfall days is calculated for Maharashtra for June, July, August, September, June to September and Annual and are shown in Figure 13 -18. In the month of June the maximum number of heavy rainfall days lies in the range of 0.3 to 1 days especially in north eastern districts.

In the month of July the maximum number of heavy rainfall days lies in the range of 1 to 2 days especially in north eastern districts. Heavy rainfall days are 0 days for the rest of districts of state average frequency is between 0.2-0.5.

During August also the maximum number of heavy rainfall days lies in the range of 1 to 2 days especially in north eastern districts.

In September the maximum number of heavy rainfall days lies in the range of 0.4 to 1 days especially in central to north eastern districts.

During June to September the maximum number of heavy rainfall days lies in the range of 2 to 3 days especially in upper north eastern districts. While minimum number of Heavy rainfall days lies in the range of 0.6 to 1 days in western districts.

During the entire year the maximum number of heavy rainfall days lies in the range of 3 to 4 days especially in north eastern districts. While minimum number of Heavy rainfall days lies in the range of 0.6 to 1 days especially in north western districts. Whereas
in remaining districts, the number of Heavy rainfall days lies in the range of 1 to 2 days.

Fig. 13 Average frequency of heavy rainfall days: June

Fig. 14 Average frequency of rainy days: July

Fig. 15 Average frequency of heavy rainfall days: August

Fig. 16 Average frequency of heavy rainfall days: September

Fig. 17 Average frequency of heavy rainfall days: JJAS

Fig. 18 Average frequency of heavy rainfall days: Annual
5.3 Average frequency of Dry days

The average frequency of dry days is calculated for Maharashtra for June, July, August, September, June to September and Annual and are shown in Figure 19 -24. In the month of June the maximum number of dry days lies in the range of 26 to 27 days especially in south eastern districts and some parts of far north western districts of state. While minimum number of dry days lies in the range of 22 to 23 days especially in north eastern(parts) districts. In remaining districts, the number of dry days lies in the range of 23 to 25 days.

During the month of July the maximum number of dry days lies in the range of 23 to 25 days especially in north western parts of the state. While minimum number of dry days lies in the range of 17 to 18 days especially in some eastern and central parts of state. Whereas in remaining districts, the number of dry days lies in the range of 19 to 22 days.

In the month of August the maximum number of dry days lies in the range of 29 to 30 days especially in north eastern districts of state. While minimum number of dry days lies in the range of 27 to 28 days especially in southern districts of state. Whereas in remaining districts, the number of dry days lies in the range of 28 to 29 days.

In the month of September the maximum number of dry days lies in the range of 25 to 27 days especially in north western districts of state. While minimum number of dry days lies in the range of 22 to 23 days especially in north eastern parts of state. Whereas in remaining districts, the number of dry days lies in the range of 23 to 25 days.

During the period June to September the maximum number of dry days lies in the range of 92 to 98 days especially (in some parts) districts of north west to south eastern. While minimum number of dry days lies in the range of 72 to 77 days especially in north eastern districts. Whereas in remaining districts, the number of dry days lies in the range of 77 to 92 days.

During the entire year the maximum number of dry days lies in the range of 310 to 323 days especially in some parts of southern districts. While minimum number of dry days lies in the range of 266 to 277 days especially in north eastern districts of state. Rest of districts (north to southward) have number of dry days lies in range of 278 to 310 days.
Fig. 19 Average frequency of dry days: June

Fig. 20 Average frequency of dry days: July

Fig. 21 Average frequency of dry days: August

Fig. 22 Average frequency of dry days: September

Fig. 23 Average frequency of dry days: JJAS

Fig. 24 Average frequency of dry days: Annual
6 Trends in the frequencies of different rainfall events

6.1 Trend in frequency of Rainy days

The Trend in frequency of rainy days is calculated for the rain gauge stations of Maharashtra for June, July, August, September, June to September and Annual. Figure 25 shows that in the month of June there is a significantly increasing trend in rainy days in stations of Kurukshetra, Jhajjar, Rewari, Faridabad, Palwal districts and significantly decreasing trend in rainy days in some stations of Kaithal district. While remaining districts did not show any significant change.

Figure 26 depicts that in the month of July there is a significantly decreasing trend in rainy days in stations of Panchkula, Kaithal, Sonipat, Rohtak, Mahendragarh While remaining districts did not show any significant change.

In the month of August there is a significantly increasing trend in rainy days in stations in Jhajjar, Mahendragarh district Whereas there is a significantly decreasing trend in rainy days in stations in Faridabad, Palwal, Ambala, Kaithal, Karnal districts. While remaining districts did not show any significant change (Figure 27).

Figure 28 shows that in the month of September there is a significantly increasing trend in rainy days in stations in Jhajjar, Mahendragarh, Rewari districts. Whereas there is a significantly decreasing trend in rainy days in stations in Kaithal districts. While remaining districts did not show any significant change.

During the period June to September there is a significantly increasing trend in rainy days in stations in Jhajjar districts. Whereas there is a significantly decreasing trend in rainy days in stations in Faridabad, Palwal, Bhiwani, Kaithal, Kurukshetra, Ambala, Yamunanagar, Panchkula districts. While remaining districts did not show any significant change (Figure 29).

Figure 30 shows trend in frequency of rainy days during the entire year, there is a significantly increasing trend in rainy days in stations of Karnal, Jind, Sonipat, Jhajjar, Charkhi Dadri, Rewari, Palwal districts. Whereas there is a significantly decreasing trend in rainy days in Stations of Faridabad, Kaithak, Kurukshetra, Yamunanagar, Ambala, Panchkula districts. While remaining districts did not show any significant change.
Fig. 25 Trend in frequency of rainy days: June

Fig. 26 Trend in frequency of rainy days: July

Fig. 27 Trend in frequency of rainy days: August

Fig. 28 Trend in frequency of rainy days: September

Fig. 29 Trend in frequency of rainy days: JJAS

Fig. 30 Trend in frequency of rainy days: Annual
6.2 Trend in frequency of Heavy rainfall days

The Trend in frequency of Heavy days is calculated for Maharashtra for June, July, August, September, June to September and Annual and are shown in Figure 31-36. In the month of June there is a significantly increasing trend in Heavy rainfall days in stations of Hisar, Jind, Rewari districts. While remaining districts did not show any significant change.

In the month of July there is a significantly increasing trend in Heavy rainfall days in stations in Sonipat district. Whereas there is a significantly decreasing trend in Heavy rainfall days in stations in Fatehabad, Kaithal, Karnal, Amabala districts. While remaining districts did not show any significant change.

During the month of August there is a significantly increasing trend in Heavy rainfall days in stations in Jhajjar and southern parts of Mahendragarh districts. Whereas there is a significantly decreasing trend in Heavy rainfall days in stations in Rewari, northern parts of Mahendragarh, Palwal, Rohtak, Sonipat, Kaithal districts. While remaining districts did not show any significant change.

In the month of September there is a significantly decreasing trend in Heavy rainfall days in Sonipat district. While remaining districts did not show any significant change.

During June to September there is a significantly increasing trend in Heavy rainfall days in stations in Jind, Jhajjar, Mahendragarh districts. Whereas there is a significantly decreasing trend in Heavy rainfall days in stations in Mewat, Sirsa, Fatehabad, Kaithal, Kurukshtera, Ambala, Panchkula districts. While remaining districts did not show any significant change.

During the entire year there is a significantly increasing trend in Heavy rainfall days in Jind, Jhajjar, Mahendragarh districts. Whereas there is a significantly decreasing trend in Heavy rainfall days in Fatehabad, Kaithal, Karnal, Kurukshtera, Yamunanagar, Ambala, Panchkula districts. While remaining districts did not show any significant change.
Fig. 31 Trend in frequency of heavy rainfall days: June

Fig. 32 Trend in frequency of heavy rainfall days: July

Fig. 33 Trend in frequency of heavy rainfall days: August

Fig. 34 Trend in frequency of heavy rainfall days: September

Fig. 35 Trend in frequency of heavy rainfall days: JJAS

Fig. 36 Trend in frequency of heavy rainfall days: Annual
6.3 Trend in frequency of Dry days

The Trend in frequency of dry days is calculated for Maharashtra for June, July, August, September, June to September and Annual and is shown in Figure 37-42. In the month of June there is a significantly increasing trend in dry days in some parts of Palwal, Faridabad and Kaithal districts. Whereas there is a significantly decreasing trend in dry days in Ambala, Kaithal, Yamunanagar, Hisar, Jhajjar, Mahendragarh, Rewari, Mewat, Gurgaon, some parts of Faridabad and Palwal districts. While remaining districts did not show any significant change.

In the month of July there is a significantly increasing trend in dry days in Mahendragarh, Faridabad districts. Whereas there is a significantly decreasing trend in dry days in Kaithal, Rohtak districts. While remaining districts did not show any significant change.

During the month of August there is a significantly increasing trend in dry days in Kaithal, Ambala, Yamunanagar districts. Whereas there is a significantly decreasing trend in dry days in Sirsa, Lower Kaithal, Rohatak and Jhajjar districts. While remaining districts did not show any significant change.

In September there is a significantly increasing trend in dry days in Faridabad, Kaithal, Ambala, Panchkula districts. Whereas there is a significantly decreasing trend in dry days in Hisar, Bhiwani, Rohtak, Jhajjar districts. While remaining districts did not show any significant change.

During the period June to September there is a significantly increasing trend in dry days in Palwal, Sonipat, Karnal, Ambala districts. Whereas there is a significantly decreasing trend in dry days in Fatehabad, Hisar, Bhiwani, Rohtak, Jhajjar, Charkhi Dadri, Mahendragarh, Kaithal, Kurukshetra districts. While remaining districts did not show any significant change.

During the entire year there is a significantly increasing trend in dry days in Ambala, Lower Karnal, Lower Sonipat, Rewari, Palwal districts. Whereas there is a significantly decreasing trend in dry days in Rohtak, Bhiwani, Hisar, Fatehabad, Kaithal, Kurukshetra, Yamunanagar districts. While remaining districts did not show any significant change.
Fig. 37 Trend in frequency of dry days: June

Fig. 38 Trend in frequency of dry days: July

Fig. 39 Trend in frequency of dry days: August

Fig. 40 Trend in frequency of dry days: September

Fig. 41 Trend in frequency of dry days: JJAS

Fig. 42 Trend in frequency of dry days: Annual
7. Conclusions

In the present study we have investigated the rainfall pattern and its variability and also changes based on recent 30 years data. In the analysis we have considered monsoon months, the monsoon season and annual scale. The spatial scale has been considered from state to district for study of rainfall total and stations are being considered for seeing intensities of rainfall. The analysis brought many significant features of rainfall pattern and can be used for water agricultural managements. Some of the important results can be summarized as:

- Haryana gets maximum rainfall in August (33% of SW monsoon rainfall) followed by July (32% of SW monsoon rainfall).
- 82% of annual rainfall receives during southwest monsoon rainfall (June –September).
- Kaithal, Faridabad and Mewat districts receive 85-86% of annual rainfall in SW monsoon season while Sirsa, Fatehabad and Jind districts receive 77-78% of annual rainfall in SW monsoon season.
- No significant increasing/decreasing trends in June monthly rainfall.
- Significantly decreasing trends in monthly rainfall in July are seen at Sirsa, Kaithal, Panchkula districts, in August at Kaithal, Panipat, Panchkula districts, in September at Panchkula district are seen.
- Maximum rainfall received during the SW monsoon season in Yamunanagar, Panchkula and Ambala districts (798mm-891mm) while Sirsa, Fatehabad and receive the lowest rainfall (218-282mm). Sirsa district receives lowest rainfall of 218mm.
- Maximum rainfall received during the year in Yamunanagar, Panchkula and Ambala districts (968mm-1054mm) while Sirsa receives lowest annual rainfall of 283mm.
- Significantly decreasing trend in SW monsoon rainfall has been noticed in Ambala, Panchkula, Kaithal, Panipat, Bhiwani and Charkhi Dadri district while no district show significant decreasing trend.
- In annual rainfall Ambala, Panchkula, Panipat districts show significant decreasing trend while no district shows significantly increasing trend.
- Panchkula and parts of Ambala and Yamunanagar districts receive on an average 27-32 rainy days (daily rainfall >=2.5mm) out of 122 days of SW monsoon season while upper parts of Sirsa, Fatehabad districts gets 14-18 rainy days and central parts of Haryana get even less than 27 rainy days.
- For heavy to extremely heavy rainfall (daily rainfall >=64.5mm) parts of Panchkula, Ambala and Yamunanagar districts get 2-3 days during the SW monsoon season, western parts (Sirsa, Fatehabad, Hisa, Bhiwani districts) of the state get around 0-1 heavy to extremely heavy rainfall days.
- Number of dry days is maximum over central and Southern parts of the state (87-92) dry days out of 122 days during the SW monsoon season while on an average 289-300 dry days in 365 days have been noticed in many parts of state.
During the period June to September there is a significantly increasing trend in the frequency of Rainy days in stations in Jhajjar districts. Whereas there is a significantly decreasing trend in Rainy days in stations Bhiwani, Faridabad, Kaithal, Kurukshetra, Ambala, Panchkula and Yamunanagar districts.

During the entire year there is a significant increase in Rainy days in Jhajjar, Rewari, Palwal, Jind, Karnal districts. Whereas there is a significant decrease in Rainy days in north eastern districts viz Kaithal, Kurukshetra, Ambala, Yamunanagar, Panchkula.

During the period June to September there is a significant increase in Heavy rainfall days in Jind, Jhajjar and Mahendragarh districts. Whereas there is a significant decrease in Heavy rainfall days in Sirsa, Fatehabad, Kaithal, Kurukshetra, Ambala, Panchakula. While remaining districts did not show any significant change.

During the entire year there is a significant increase in Heavy rainfall days in Jind, Jhajjar and Mahendragarh districts. Whereas there is a significant decrease in Heavy rainfall days in Faehabad, Kaithal, Kurukshetra, Ambala, Panchakula, Yamunaganagar districts.

During June to September there is a significant increase in dry days in Ambala, Karnal, Sonipat, Palwal districts. Whereas there is a significant decrease in dry days in Fatehabad, Hisar, Bhiwani, Mahendragarh, Rohtak, Jhajjar, Kaithal, Kurukshetra districts.

During the entire year there is a significant increase in dry days in Ambala, Rewari, Karnal, Palwal districts. Whereas there is a significant decrease in dry days in Fatehabad, Hisar, Bhiwani, Rohtak, Jhajjar, Kaithal, Kurukshetra, Yamunanagar, Gurugram districts.

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References:

The report brings out observed rainfall variability and trends over the state as an impact of climate change based on recent 30 years of data (1981-2018).

Rainfall pattern of monsoon months, south west monsoon season and annual of the state and its districts as well as extreme rainfall event of different intensity of stations are analysed.