

***Trends in Seasonal Rainfall
and
Heavy Rainfall Events during South West Monsoon
Season over Indian Region***

Nilesh K. Waghlikar¹, K. C. Sinha Ray², P. N. Sen²,
P. Pradeep Kumar²

¹ Sir Parashurambhau College, Pune – 411030, India,

² Department of Atmospheric and Space Sciences, Savitribai Phule Pune
University

(Formerly : University of Pune), Pune – 411007, India

Introduction :

Changing characteristics of rainfall during recent years have resulted in severe droughts and floods in many parts of the country causing large scale destruction of life and property.

The study of spatial and temporal variation of the rainfall at seasonal scale is important as the economy of India is mainly based on the agricultural practices and has great relevance in the context of planning and policy formulation.

Data and Methodology

Data :

Source : High Resolution Daily Gridded Rainfall prepared by the IMD

Resolution : $0.25^{\circ} \times 0.25^{\circ}$

Area : Indian land mass region (6.5–38.5 N and 66.5–100.5 E)

** In present analysis Jammu and Kashmir is not included*

Period : 1901-2013.

** Period considered for analysis : 1951-2011*

Seasons :

Pre-monsoon March–May

Monsoon June–September

Post-monsoon October–December

Methodology :

The non-parametric **Mann-Kendall test** was applied to detect monotonic trends in rainfall in each season. These **trends are tested at 5% level of significance.**

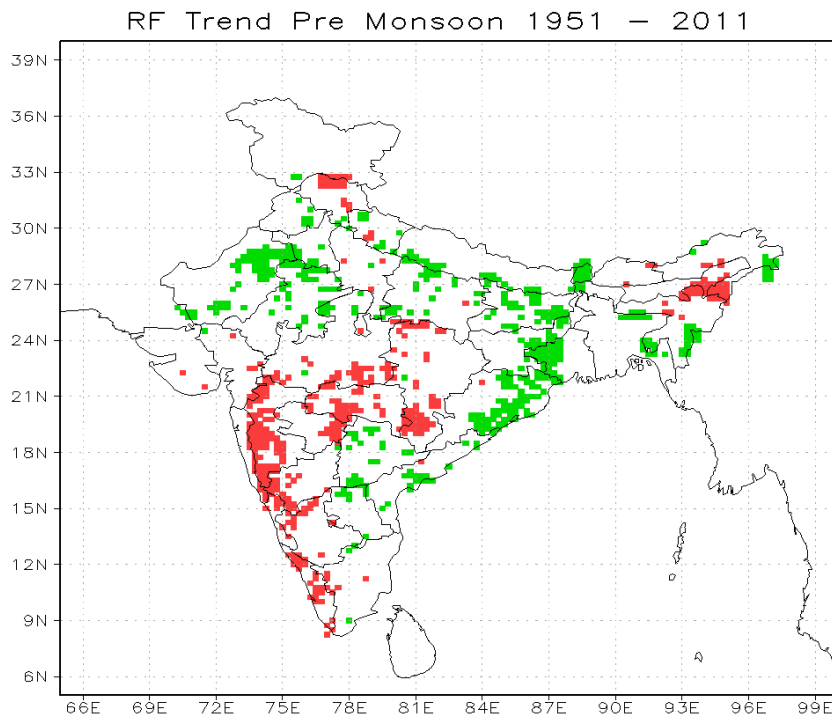
Some Literature Survey

- Most of the studies on rainfall trends over India are based on the rainfall series constructed by Parthasarathy et. al. (1994).
- Mooley and Parthasarathy (1984), found that the monsoon rainfall is without any trend and mainly random in nature over a long period of time, particularly on the all India time scale.
- on the spatial scale, existence of trends was noticed by Parthasarathy (1984) and Rupa Kumar et al. (1992).
- Study on regional scale is also made by many researchers to find long terms trends in rainfall : Parthasarathy and Dhar (1974) , Koteswaram & Alvi (1969), Jagannathan & Parthasarathy (1973), Raghavendra (1974), Chaudhary & Abhyankar (1979), Pant & Hingane (1988) reported changes in rainfall trends over various meteorological subdivisions over India.

Rupa Kumar *et al.*(1992), Subbaramayya and Naidu (1992), Kothyari and Singh (1996), Ramesh and Goswami(2007), Pattanaik (2007), Kumar et. al. (2010), Rajeevan *et al.*(2006) and Guhathakurta and Rajeevan (2008)

Seasonal Trends :

Pre – Monsoon Season : (MAM)

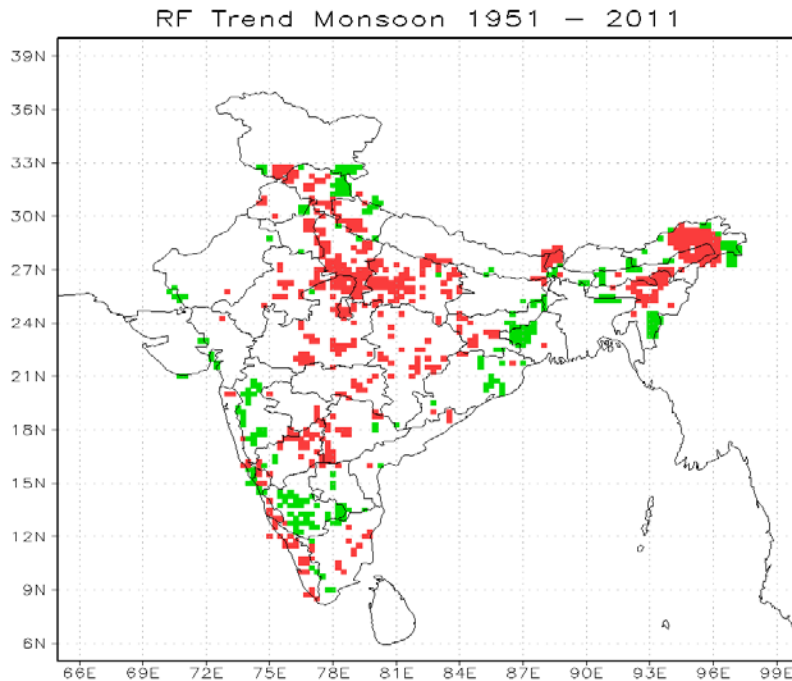


Decreasing Trend :

Konkan and Goa, Kerala, some parts of south interior Karnataka, Madhya Maharashtra, Vidharbha, southern parts of Madhya Pradesh, Chattisgarh, northern parts of Himachal Pradesh, some parts of Assam and Meghalaya

Increasing trend : Rajasthan, some parts of Punjab and Haryana, some parts of Uttaranchal, East Uttar Pradesh, Bihar, Sub Himalayan West Bengal and Sikkim, Gangetic West Bengal and Orissa, some part of Nagaland, Manipur, Mizoram and Tripura

South West Monsoon Season : (JJAS)

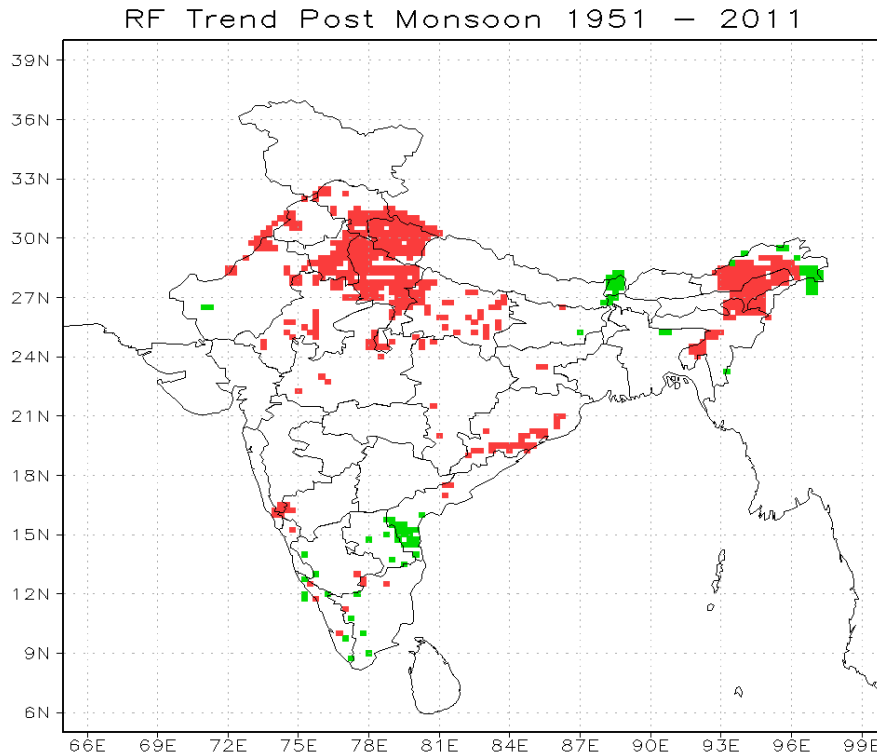


Decreasing trend :

Kerala, Tamilnadu, North interior Karnataka, Telangana, Vidarbha, whole Madhya Pradesh, Chattisgarh, Esat Rajashtan, whole Uttar Pradesh, Himachal Pradesh, Sikkim, Arunachal Pradesh, Assam and Meghalaya.

Increasing Trend : Madhya Maharashtra, south interior Karnataka, Rayalseema, some parts of Orissa, Gangetic West Bengal, some parts of Jharkhand, eastern parts of Himachal Pradesh, some parts of Uttaranchal, Assam and Meghalaya, some parts of Arunachal some parts of Pradesh, Nagaland, Manipur, Mizoram and Tripura

Post – Monsoon Season : (MAM)

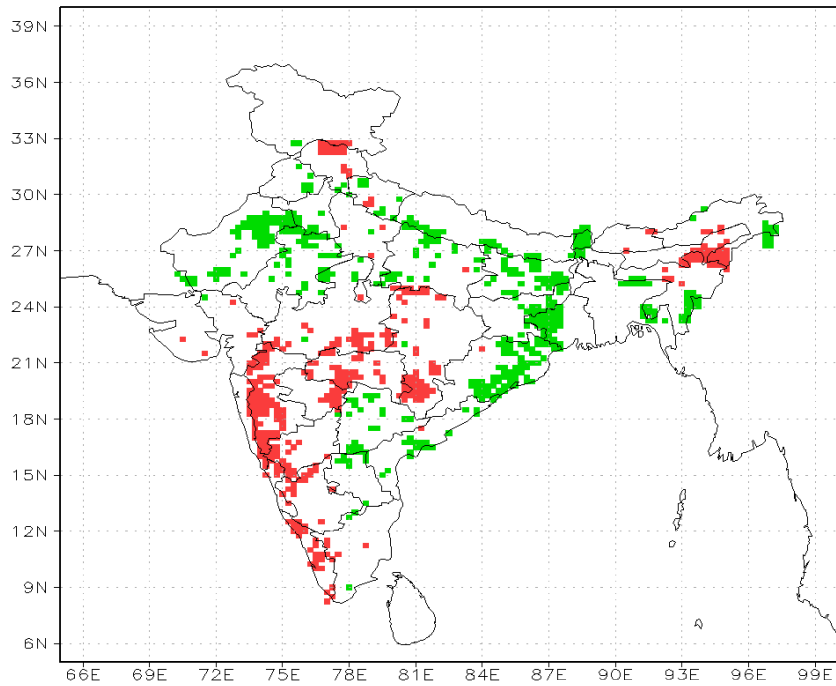


Decreasing trend :

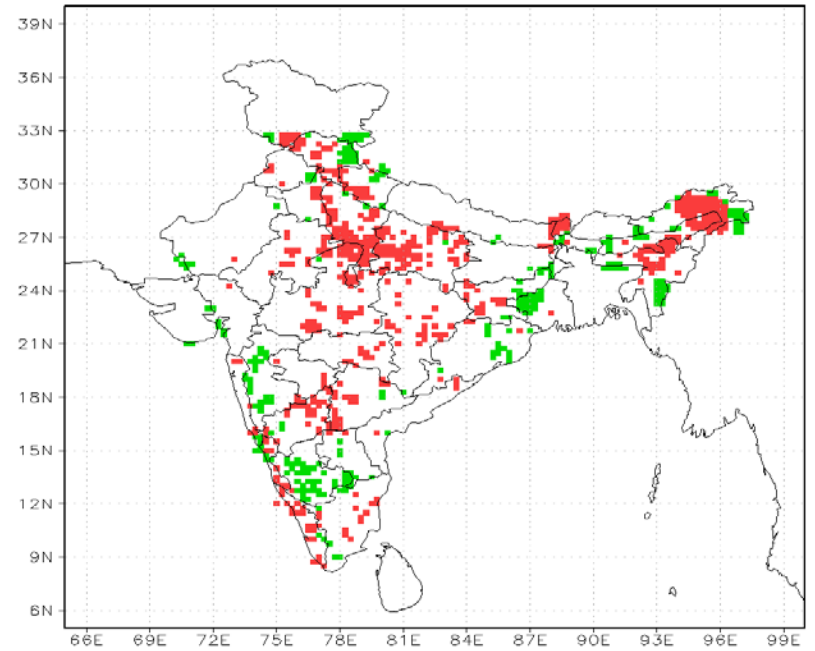
some parts of Punjab, Himachal Pradesh, Uttaranchal, Haryana, Chandigarh and Delhi, Arunachal Pradesh, some parts of east and west Rajasthan, some parts of west Madhya Pradesh, some parts of east Uttar Pradesh, some parts of Orissa

Increasing trend : some grids in Kerala, southern parts of coastal Karnataka. Sikkim and some parts of Arunachal Pradesh

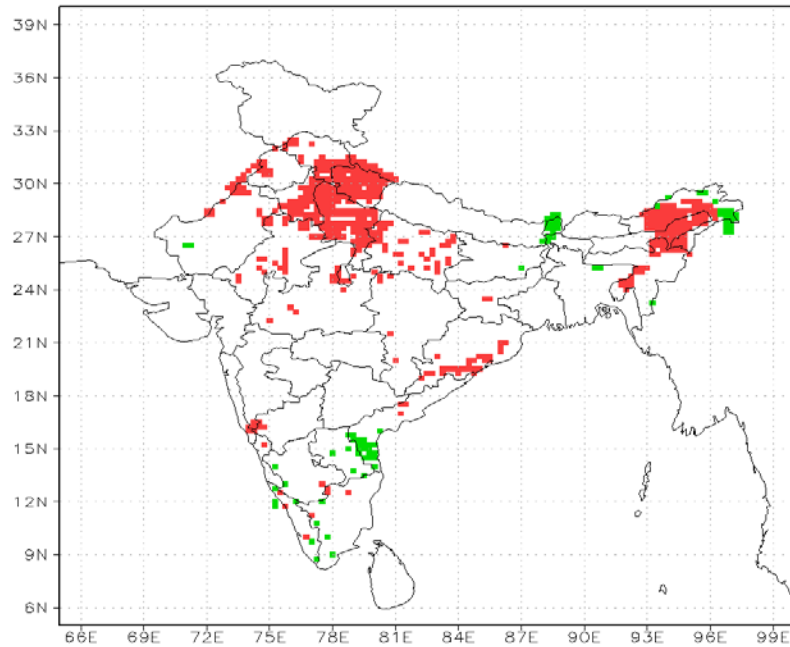
RF Trend Pre Monsoon 1951 - 2011



RF Trend Monsoon 1951 - 2011



RF Trend Post Monsoon 1951 - 2011



Trends in Heavy Rainfall Events during South West Monsoon Season

Calculation of Threshold value for heavy rainfall event

- The threshold value based on percentile calculations.
- We have considered rainfall series of all the rainy days in south west monsoon season over the period 1951 – 2011
- The 90th percentile values computed from the series for south west monsoon season are used to define the threshold for heavy rainfall event.
- These threshold values vary from grid cell to grid cell but not year to year.

Definition of Heavy Rainfall Event

An event in which **daily rainfall is greater than 90th percentile threshold** is considered as **heavy rainfall event**.

- Only rainy days are considered for finding out trend in heavy rainfall events. For monsoon season in each year such events : daily RF \geq 90th percentile threshold value are added to get total number of heavy rainfall days in the year

Some Literature Survey

- **Sinha ray et. al. (2000)** studied the changes in heavy rainfall days using **station data for 151 stations** all over India for a period of 1901 to 1990. If the daily rainfall over a station is **7 cm or more**, then they defined it as heavy rainfall. Their study shows that, **during monsoon season number of stations in Kutch and Gujarat and most of the stations over west coast of India show increasing trend in heavy rainfall events.**
- Study by **Sen Roy and Balling [2003]** has shown that the trends in the number of **extreme precipitation events are increasing in major parts of the country.**
- **Rajeevan et. al. (2008)** examined the variability and long term trends over central India using 104 years (1901-2004) of high resolution daily gridded rainfall. They concluded that, under the strong coupling between the equatorial Indian Ocean SST and extreme events, **the frequency of extreme rainfall events and risk of floods may increase over the central India.**
- **Pal and Al-Tabbaa [2009]** have studied changes in extreme monsoon rainfall (both deficit and excess cases) for the period of 1871 to 2005 over five regions in India and concluded that there is **negative tendency in extreme monsoon seasonal precipitation.** They have also reported that this **tendency is stronger in the north-east, west-central and central north-east India, the regions of usual maximum monsoon rainfall, making the north India most vulnerable to summer droughts.**

➤ **Goswami *et al* (2006)** using the daily gridded data of India Meteorological Department for the period 1951–2003, examined the trend of extreme rainfall over India. However their study was confined to the central India. In their study, they have reported an **increase in the frequency and the magnitude of extreme rain events and a significant decreasing trend in the frequency of moderate events over central India.**

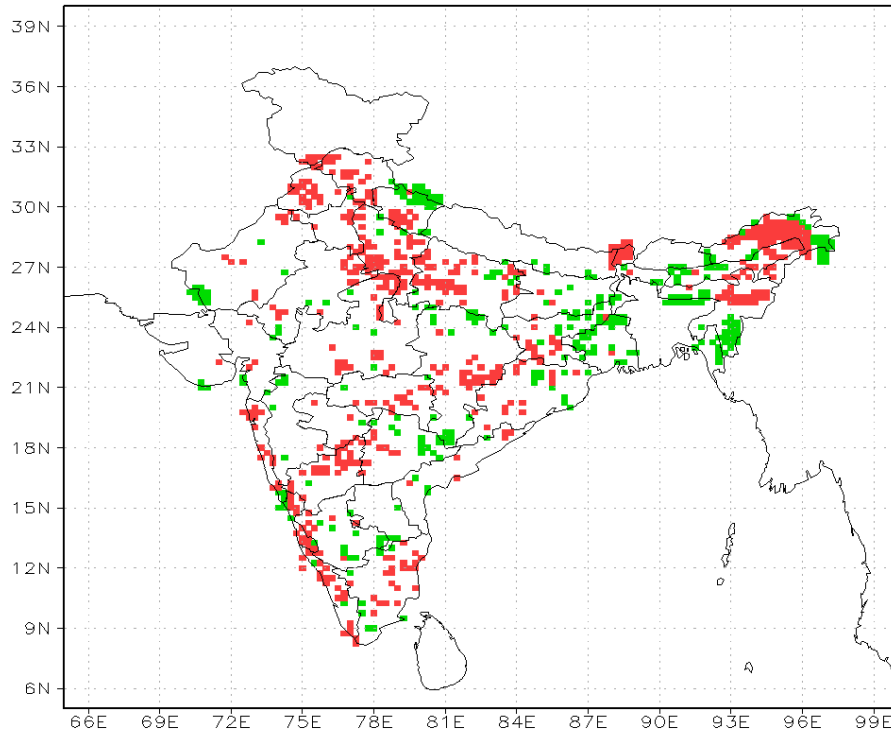
➤ Study of heavy rainfall events over urban areas by **Kishtawal et. al. (2009)** indicated that the **extreme rainfall events show an increased trend over both urban and rural areas.** They have also stated that the trend over urban areas is larger and statistically more significant as compared to that over rural areas. They have also concluded that **the increasing trend in the frequency of heavy rainfall events over the Indian monsoon region is more likely to be over the regions where the pace of urbanization is faster.**

➤ **Krishnamurthy et. al. (2009)** have studied the changing frequency and intensity of rainfall extremes by using daily gridded data of India Meteorological Department for the period 1951–2003. They have used **90th and 99th percentile values only for the days with non zero rainfall.** Their study concluded that the **extreme precipitation frequency over many parts of India also appears to exhibit a decreasing trend, especially for the exceedance of the 90th percentile of daily rainfall.**

- **Pattaknaik et. al. (2010)** have studied spatial and temporal variability of extreme rainfall events over India using daily gridded rainfall data for period of 1951 to 2005 prepared by India Meteorological Department. They have classified rainfall events using fixed threshold values and suggested that **frequency of the occurrence of extreme rainfall events over India during JJAS shows spatial variations over the west coast, central parts of India and northeast India.** They have also reported that the **average frequency of extreme rainfall events along with the contribution of extreme rainfall events to the seasonal rainfall shows a significant increasing trend (above the 98% confidence level) over the Indian region during JJAS.**
- **Guhathkurtha et. al (2011)** has studied trends in frequency of heavy rainfall days by using station data for the period of 1901 to 2005 for the Indian region. They have studied very heavy and extremely heavy rainfall events using **fix threshold values and shown that heavy rainfall events are decreasing in the major parts of the central and north India and these events are increasing in peninsular, east and north east India.**
- Trend analysis by **Dash et. al. (2011)** indicated that **during the summer monsoon season, short spell rain events with heavy intensity have increased over India as a whole.**

Trends in Heavy Rainfall Events during South West Monsoon Season :

MonsoonRF > 90th pc RD : Trend 1951 - 2011



Decreasing trend :

Himachal Pradesh, Punjab, southern parts of Uttaranchal, East and West Uttar Pradesh, Sikkim, Arunachal Pradesh, northern parts of Nagaland, Manipur, Mizoram and Tripura, Jharkhand, eastern parts of Chattisgarh, some parts of Vidarbha, whole west coast, north interior Karnataka, western parts of telangana, and Tamilnadu

Increasing trend :

Northern parts of Uttaranchal, some parts of Bihar, Gangetic West Bengal, Assam and Meghalaya, southern parts of Nagaland, Manipur, Mizoram and Tripura, some parts of Orissa, some grids in Madhya Pradesh, southern parts of Chattisgarh, Goa, few grids in Madhya Maharashtra, Telangana, Karnataka

Conclusions

Seasonal Trends :

- The pre monsoon rainfall is decreasing over west coast states and increasing over east coast states. Northern Indian states also show increasing trend in pre monsoon rainfall.
- During south west monsoon season almost whole country show significantly decreasing trend in rainfall and only some parts of eight meteorological sub divisions show increasing trend in rainfall.
- During post monsoon season, northern and north east Indian states show decreasing trend in post monsoon rainfall, while increasing trend is observed over some grids in south Indian states.
- It is also observed that most of the parts showing decreasing/increasing trend in pre monsoon season show increasing/decreasing trend in south west monsoon season.

Trends in Heavy Rainfall Events :

Overall, heavy rainfall events are decreasing over most of the parts of the country.

West coast and northern Indian states – Punjab, and Uttar Pradesh are most affected states., where the heavy rainfall events are decreasing.

Thank You