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**Original Research Article**

# Trend Analysis of Precipitation over Marathwada Region, Maharashtra Using RClimDEX

**S.S. Deshmukh*, V.S. Misal and A.M. Khobragade**

Department of Agricultural Meteorology, College of Agriculture, Parbhani, Maharashtra, India

**Corresponding author*

**A B S T R A C T**

In Marathwada region the annual rainfall is highly variable, ranging from less than approximately 700 mm–800 mm and its distribution is unevenly spread between all the district locations. Climate change threatens to increase air temperatures and evapotranspiration, increase the risk of intense rainstorms, and increase the risk of heat waves associated with drought. The objective of this study is to assess the change trends of daily precipitation extremes over Marathwada region in Maharashtra state which includes Aurangabad, Beed, Latur, Osmanabad, Nanded, Jalna and Parbhani district locations during the period between 1981 and – 2010. Precipitation indices do not illustrate statistically significant trends across the whole region. The annual trends of decadal precipitation events showed that there is >= 1mm rainfall and simple daily intensity index (SDII) has significant trend in Marathwada region among the all selected districts of Marathwada region. While, the higher decadal trends of precipitation events are observed in Jalna, Nanded, Osmanabad and Parbhani district (i.e. 1991-2000 and 2001-2010), respectively. The overall study over Marathwada region shows that decrease in rainfall trend. There is unpredictable and contemplated rainfall over the entire district. Data were subjected to quality check, and indices of climate extremes were calculated by RClimDex software.

**Keywords**

Temperature, Trend, Precipitation, Extremes, Index and variability

## Introduction

Study and understanding of changes in extreme precipitation events is of great importance because of their large impact on society and ecosystems compared to changes in mean precipitation (Hartmann *et al.*, 2013). The main objective of constructing climate extremes indices is to use for climate change monitoring and detection studies. Records around the world have shown mixed and non-significant long-term trends in mean precipitation changes (Hartmann *et al.*, 2013). However, averaged over the Northern Hemisphere mid-latitudes, precipitation has increased since 1951 (Intergovernmental Panel on Climate Change [IPCC, 2014). IPCC has reported that substantial increases were found in annual heavy precipitation events (disproportionately high compared to changes in mean precipitation) over many mid-latitude regions between 1951 and 2003, even in the regions where a reduction in annual total precipitation had been observed (Hartmann *et al.*, 2013).

The climate communities unanimously agree that any changes in the frequency or intensity of daily precipitation events would have deep effect on the nature and societies. It is therefore very crucial to analyze precipitation events. The monitoring, detection and

attribution of changes in precipitation usually need daily resolution data.

## Materials and Methods

### Location and extent

Marathwada is located in the middle and south eastern portion of Maharashtra State. Godawari river basin is covered in northern part of Marathwada region and southern part of Marathwada region is covered by Krishna river basin. Marathwada region lies between 17o 35' to 20o41' North Latitude and 70o 40' to 78 o 16' East Longitude.

The RClimDex model is developed and maintained by Xuebin Zhang and Feng Yang. It was designed to provide a user friendly interface to compute indices of climate extremes. It computes all 27 core indices recommended by the CCl/CLIVAR Expert Team for Climate Change Detection Monitoring and Indices (ETCCDMI) as well as some other temperature and precipitation indices with user defined thresholds.

A wet day is defined when RR >= 1 mm and a dry day when RR< 1 mm. All indices are calculated annually from January to December; In this study nn is 25mm; RR is the Daily Rainfall Rate.

### How to install R

RClimDex requires the base package of R and graphic user interface. The installation of R involves a very simple procedure. 1) Connect to the R project website at http://www.r-project.org, 2) Follow the links to download the most recent version of R for your computer operating system from any mirror site of CRAN.

For Microsoft Windows (95, 98, 2000, XP, 07 and 10), download the Windows setup program. Run that program and R will be automatically installed in your computer, with a short cut to R on your desktop. The TclTk is included in the default installation of R 1.9.0 or later versions. It may need to be installed separately if you are running an earlier version of R.

### How to run R

Under the Windows environment, double click the R icon on your desktop, or launch it through Windows "start" menu. This usually gets you into the R user interface. For some computers, you may need to first setup an environment variable called "HOME". See R for Windows FAQ for details if you have any problems. Under a unix environment, just run R to give you the R console. Exit from R by entering q in the R console under both Windows and unix. Under Windows, you may also click "File" menu and then "Exit".

## Results and Discussions

The decadal trends in precipitation extremes from 1981-1990, 1991-2000 and 2001-2010 are higher to lower as compared to precipitation extremes. It shows a variability pattern until the end of the decadal years and annual mean precipitation showed that >= 1mm among all the districts (Table 1 and 2).

### Result and trend annual analysis of precipitation for the Aurangabad district

The decadal precipitation events from 1981-1990 such as analysis of decadal trends in annual precipitation, there was increasing in precipitation in the year 1989 and 1990 while in other decades it shows decreasing trend. The decadal precipitation events from 1990-2000 there was increasing in precipitation in the year 1991,1992 and 1999 while in other decades it shows decreasing trend The decadal precipitation events from 2001-2010,

there was increasing in precipitation in the year 2002, 2005, 2006, 2007 and 2010 while in other decades it shows decreasing trend in the Aurangabad district of Marathwada region.

## Result and trend annual analysis of precipitation for the Beed district

Results presented in the decadal precipitation events from 1981-1990 and after analysis of decadal trends of annual precipitation shows that, there was significant change and increasing in precipitation in year 1981, 1983, 1984, 1986 and 1990 while in other decades it shows decreasing trend. Decadal precipitation events from 1991-2000, there was significant change and increasing in precipitation in year 1992, 1993, 1996, 1999 and 2000 while in other decades it shows decreasing trend . From 2000-2010, there was significant change and increasing in precipitation in year 2002, 2005, 2006 and 2008 while in other decades it shows decreasing trend in the Beed district of Marathwada region.

## Result and trend annual analysis of Precipitation for the Jalna district

The decadal precipitation events from 1981-1990, there was increasing in precipitation in the year 1982, 1983, 1987 and 1988 while in other decades it shows medium trend however, decadal precipitation events from 1991-2000, there was increasing in precipitation in the year 1992, 1993, 1997 and 2000 while in other decades it shows decreasing trend. The decadal precipitation events from 2001-2010, there was decreasing in precipitation in the year 2003, 2005 and 2010 while in other decades it shows increasing trend in the Jalna district of Marathwada region.

## Result and trend annual analysis of Precipitation for the Latur district

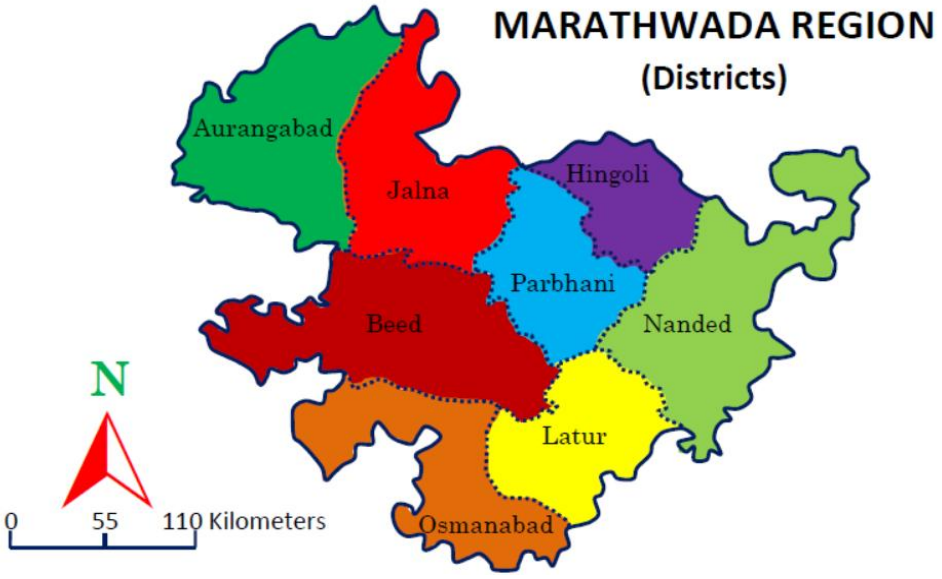
The decadal precipitation events from 1981-1990 and after analysis of decadal trends of annual precipitation shows that, there was significant change and increasing in precipitation during year 1983, 1984, 1986 and 1989 while in other decades it shows decreasing trend. The decadal precipitation events from 1991-2000, there was significant change and increasing in precipitation in year 1991, 1992, 1995 and 2000 while in other decades it shows decreasing trend. However, decadal precipitation events from 2000-2010, there was significant change and increasing in precipitation in year 2003, 2004, 2005, 2006 and 2008 while in other decades it shows decreasing trend in the Latur district of Marathwada region.

**Table.1** Geographical co-ordinates and location names used in the study area

| Location / District | Base Period | Latitude | Longitude |
|---|---|---|---|
| Aurangabad | 1981-2010 | $19.8762^0$N | $75.3433^0$E |
| Beed | 1981-2010 | $18.9891^0$N | $75.7601^0$E |
| Jalna | 1981-2010 | $19.8297^0$N | $75.8800^0$E |
| Latur | 1981-2010 | $18.4088^0$N | $76.5604^0$E |
| Nanded | 1981-2010 | $19.1383^0$N | $77.3210^0$E |
| Osmanabad | 1981-2010 | $18.2070^0$N | $76.1784^0$E |
| Parbhani | 1981-2010 | $19.2644^0$N | $76.6413^0$E |

**Table.2** Summary information of the used precipitation Indices

| Index | Descriptive Name | Definition | Units |
|---|---|---|---|
| **PRCPTOT** | wet day precipitation | annual total precipitation from wet days | mm |
| **SDII** | simple daily intensity index | average precipitation on wet days | mm/d |
| **CDD** | consecutive dry days | maximum number of consecutive dry days | days |
| **CWD** | consecutive wet days | maximum number of consecutive wet days | days |
| **R10mm** | heavy precipitation days | annual count of days when RR >= 10 | days |
| **R20mm** | very heavy precipitation days | annual count of days when RR >= 20 | days |
| **Rnnmm**[b] | number of days above nn mm | Annual count of days when PRCP >=nn mm, nn is user defined threshold | days |
| **R95p** | very wet day precipitation | annual total precipitation when RR > 95th percentile of daily rainfall | mm |
| **R99p** | extremely wet day precipitation | annual total precipitation when RR > 99th percentile of daily rainfall | mm |
| **RX1day** | maximum 1-day precipitation | annual maximum 1-day precipitation | mm |
| **RX5day** | maximum 5-day precipitation | annual maximum consecutive 5-day precipitation | mm |



## Result and trend annual analysis of Precipitation for the Nanded district

The decadal precipitation events from 1981-1990, there was increasing in precipitation in the year 1982, 1983, 1987 and 1989 while in other decades it shows medium trend. In the decadal precipitation events from 1991-2000, there was increasing in precipitation in the year 1991, 1992, 1993, 1999 and 2000 while in other decades it shows decreasing trend while, the decadal precipitation events from 2001-2010, there was decreasing in precipitation in the year 2001, 2002, 2007, 2009 and 2010 while in other decades it shows increasing trend in the Nanded district of Marathwada region.

## Result and trend annual analysis of Precipitation for the Osmanabad district

The decadal precipitation events from 1981-1990, there was significant change and increasing in precipitation in year 1982, 1985, 1986, 1987 and 1989 while in other decades it shows decreasing trend. The decadal precipitation events from 1991-2000, there was significant change and increasing in precipitation in year 1991, 1992, 1995, 1996 and 2000 while in other decades it shows decreasing trend. While, the decadal precipitation events from 2000-, there was significant change and increasing in precipitation during the year 2002, 2004, 2006, 2008 and 2009 while in other decades it shows decreasing trend in the Osmanabad district of Marathwada region.

## Result and trend annual analysis of Precipitation for the Parbhani district

The decadal precipitation events from 1981-1990, there was increasing in precipitation in the year 1988, 1989 and 1990 while in other decades it shows medium trend.The decadal trend of precipitation events from 1991-2000, there was increasing in precipitation in the year 1992, 1993, 1994 and 2000 while in other decades it shows decreasing trend. While, in case of the decadal precipitation events from 2001-2010, there was decreasing in precipitation in the year 2001, 2002, 2005 and 2006 while in other decades it shows increasing trend in the Parbhani district of Marathwada region.

This study concludes that, among all the precipitation indices, only simple daily intensity index (SDII) has significant trend in Marathwada region. This might be originate from serious change in sum and force of precipitation around there. Overall, the after effects of precipitation files delineate that precipitation conveyance is unpredictable and contemplated over the district of Maratwada region.

Excluding simple daily intensity (SDII) index in Marathwada region, other precipitation indices don't outline measurably significant trends, while other precipitation trends demonstrate a declining pattern. Regardless of the consequences of the precipitation lists which may prompt less run off and progressively effective rainfall. Evaporation is expanding increasingly more particularly in developing seasons, and atmosphere of this locale is drawing nearer to outright semi-arid climate.

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