

# Trend analysis of Annual, Seasonal and South-west Monsoon rainfall on Sahyadri in Maharashtra

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## ABSTRACT

The result obtained from a trend analysis of the Annual and Seasonal rainfall of Sahyadri in Maharashtra. In this region, there are great disparities of the rainfall occurrence of 1983 to 2012. In the present study analyzes the trend of Post-Monsoon, Monsoon, Pre-Monsoon and Annual rainfall all over the Sahyadri from 1983 to 2012. The rainfall trend has been worked out for the entire study region on the basis of 90 raingauge stations spread all over the Sahyadri. The Amboli at an elevation of 720 meters gets average rainfall of 6800 mm. other stations of the eastern side of this belt gets average rainfall ranging between 2500 mm to 3200 mm. In the month of June, rainfall is decreasing in the study area since 1983 to 2012. The average decline trend of June month is -0.2mm, similarly the rainfall trend of July is negative (-0.84 mm). The trend of August and September month is positive (1.87 mm & 4.92 mm respectively). Rainfall is decreasing from the southern part to the northern part of Sahyadri. The rainfall pattern of June and July are shifting towards the August and September month in the study region. At the Mahableshwar and Amboli raingauge station rainfall is decreasing in the all seasons.

## 1. Introduction

Indian Meteorology Department and Indian Institute of Tropical Meteorology, Pune analyses the climate change scenario over the India. Magnitude of the climate change varies in some cases. At all India level, there is no specific trend of rainfall during last 100 years, but they observed significant increasing and decreasing trend of the annual and seasonal rainfall for the specific subdivision. It shows large variation. Sahyadri experiences extreme climatic conditions and its economy inextricably tied to climate-sensitive sectors mainly agriculture. Agriculture is the backbone of the Indian economy. Altered rainfall patterns and variability could affect hydrological systems and agricultural productivity and production. This is likely to endanger livelihoods of communities dependent on it and food security of the study region. There are experience a decline in its pre-monsoon rainfall, which is very important to pre- agriculture activity.

## 2. Study Area

Sahyadri is located in the Western side of Maharashtra. The geographical location of the Sahyadri is 15037' N to 20015' N latitude and 73014' E to 74017' E longitude. Kalsubai (1646 m.) is the highest point in the Maharashtra. The length of Sahyadri in the state is 520 Km from north to south and average width is 55 Km from east to west. Sahyadri is distributed into 11 districts of Maharashtra, i.e. Nasik, Ahmednagar, Palghar, Thane, Pune, Raigarh, Satara, Ratnagiri, Sangli, Kolhapur and Sindhudurg. Sahyadri is the main water-parting of east and west flowing rivers of Maharashtra. Krishna, Godavari, Vaitarna, Savitri, Koyana, Warna, Bhima, Vashisthi, Kukadi, Nira etc. are major river origin on Sahyadri. It is a transitional zone between

the tropical humid and semi-arid climatic zone of Western Maharashtra and Konkan.

The average temperature of Sahyadri is 240C. The western side of Sahyadri received more than 5000 mm rainfall and the leeward side of Sahyadri received less than 2000 mm rainfall. The physiography of Sahyadri brings spatial variability in rainfall distribution. The spatial distribution of rainfall is rapidly decreased towards eastward direction in few kilometers belt over high range of Sahyadri Mountain. Sahyadri has very reach in flora and fauna. Many extinct and endangers species of the World are found in this range. The Kas plateau is included in the World Heritage Site by UNISCO. In Maharashtra, very limited and systematic studies are done on climatic characteristics. However, there is more scope for the investigation of rainfall variability in this region.

## 3. Objective

- To identify annual and seasonal rainfall trend of Sahyadri.
- To analyze monthly trend in rainfall of south-west monsoon season.

## 4. Data Base and Methodology

Monthly rainfall data of 90 rain gauge stations of the Sahyadri range of the Maharashtra form the periods of 1983 to 2012 has been collected form National Data Center of India Meteorological Department, Pune and Hydrological Project, Nashik. The annual and seasonal data of the study region is compute by summation and arithmetic mean of the monthly data of the stations. To analyse the trend of seasonal (winter, pre-monsoon, southwest monsoon, post-monsoon), annual and

monthly (June, July, August, September) rainfall we have used linear trend analysis methods. IDW and cartographic methods apply for the preparation of thematic maps.

**5. Results and Discussions**

**TREND OF ANNUAL AND SEASONAL RAINFALL**

**5.1 South West Monsoon Trend**

South-West monsoon is major rain producing season in the Sahyadri; in this season more than 80 percentage of annual rainfall received. The overall rainfall in this season has shown increasing trend (5.81 mm/year). Figure 2.C is depicting rainfall pattern of Sahyadri in this season, it shown remarkable variation in the regional scale. We find 25 rainguage stations have shown decreasing trend and 65 have shown increasing trend. Highest decreasing trend has shown -65.4 mm/year at Gureghar in Satara district. After the analysis of regional pattern of rainfall significance decreasing trend has observed on the top of Sahyadri. Satara, Pune and Sindudurg district have shown significant decreasing trend during this season. Nashik and Leeward side of Pune and Kolhapur district has shown significant increasing trend. Lonavala, Khandala, Mahableshwar and Amboli hill stations have shown significant decreasing trend of monsoon rainfall recorded as the decreasing rainfall trend. For the analysis of monthly variation of rainfall series of June, July, August, and September of this region is depicted. Rainfall of these four month affected socio-economic development of this region. June rainfall has important for economic and agricultural activity of Konkan and Western Maharashtra. June rainfall has shown decreasing trend (-0.20 mm/year) in major portion of Sahyadri, whereas increasing trend have observed in northern parts of Sahyadri.

The average trend of July rainfall has decreasing (-0.85 mm/year) in the study region. In this month, 39 stations shown decreasing trend, however 6 stations out of this shown more than -10 mm/year. 51 stations recorded the increasing trend of rainfall but it increase only 3.42 mm/year. In July rainfall windward side and top portion of the Sahyadri has shown decreasing trend, however on the leeward side it shown slightly increasing trend. In August rainfall has shown slightly increasing (1.87 mm/year) trend but it shows similar pattern of decreasing at the windward and top of Sahyadri and it increasing on leeward side. Contribution of September rainfall in this season shown significant increasing (4.92 mm/year) trend in all part of the Sahyadri.

**5.2 Post Monsoon Trend**

The overall average of trend in post monsoon season is 0.22 mm/year. Post monsoon rainfall shows the decreasing trend in the 38 stations of Sahyadri (Figure 2.D). There was slightly increasing trend of rainfall over the Sahyadri for the month of October(0.20 mm/year) and November(0.16 mm/year). The trend of rainfall in December is decreasing in most of the parts of Sahyadri. Mahableshwar, Amboli and its surrounding area shown decreasing trend of rainfall. In the Sahyadri, rainfall doesn't show the specific trend.

**5.3 Winter Season Trend**

All over the Sahyadri winter rainfall trend is decreasing. The highest decreasing rainfall trend recorded in the leeward side of Sahyadri range (Figure 2. E). Winter rainfall shows decreasing

trend in the entire region upto-0.378 mm/year. In the month of January no any region has reported increasing trend of rainfall, however February has shown decreasing trend (-0.02 mm/year).

**5.4 Pre Monsoon Season Trend**

In hot season, Satara, Ahmednagar, Northern part of Pune, Nashik, all western side of Sahyadri exclude of Pune region of Sahyadri shown the decreasing trend of rainfall. The increasing trend of rainfall recorded in Southern part of Pune district; Shahuwadi, Chandgad and Panhala of Kolhapur district; Dodamarg of Sindudurg district. The trend of March rainfall is slightly increasing (0.06 mm/year) and in April month rainfall it is decreasing (-0.04 mm/year). Rainfall of May month is important for pre sowing activity of agriculture but in the study region it is decreasing (-0.14 mm/year). In overall, pre monsoon season rainfall trend shown decreasing (-0.12 mm/year).

**5.5 Annual Rainfall Trend**

The annual rainfall trend in the Sahyadri region within the state is shows in figure 2.A. The overall annual rainfall of Sahyadri shows significant increasing trend (5.8 mm/year) but at a regional level, there are large variation. Twenty seven stations in the Sahyadri region has shown decreasing trend (-65.8 to -0.32mm) and sixty three stations shown increasing trend of rainfall. The highest annual decreasing rainfall trend is shown at Gureghar (-65.8 mm/year) in Satara district and increasing at Ambai (39.5 mm/year) in Nashik district.

**Table I**  
**Trend of Sahyadri**

Sr. No.	Month / Season	Number of Stations	
		Negative Trend	Positive Trend
1	<b>June</b>	40	50
2	<b>July</b>	39	51
3	<b>August</b>	25	65
4	<b>September</b>	8	82
5	Annual	27	63
6	Pre-Monsoon	55	30
7	South-West Monsoon	25	65
8	Post Monsoon	38	52
9	Winter	43	27

**6. Conclusion**

Intergovernmental Panel on Climate Change has reported climate change scenario in the world. Based on analysis of rainfall data of 90 stations over the Sahyadri. We define trends of monthly, seasonal and annual rainfall pattern in this region. The overall trend of South-West monsoon has increase in most portion of the Sahyadri, but there are large disparities of June to September month. June and July shown decreasing trend and August and September shown increasing trend of rainfall. June rainfall is important for sowing and cultivation, but it decreasing in major portion of the Sahyadri. In future, such situation will be creating food scarcity in Maharashtra. July and August rainfall is important for fulfillment of basic need of water resource. The rainfall of June and July are shifting towards the August and September month in the study region. To reschedule cropping pattern and agriculture activity as per rainfall shifting pattern. Out of the all months, September has shown remarkable increasing trend and it fulfill whole backdrop of rainfall in June

and July. Therefore the rainfall pattern of June and July has been shifted towards the August and September during the study period. Pre monsoon rainfall is important for pre activity of agriculture but it shows decreasing pattern in whole Sahyadri range. The winter season rainfall trend is decreasing, which has importance for maintain the temperature of this season. The post monsoon season rainfall is slightly positive. It is useful for the kharif crop sowing and cultivation. The annual trend of rainfall in shown increasing (5.80 mm/year). Which is a sign for the rainfall of Sahyadri is increasing slightly from 1983-2012. The demand water increasing day by days and the water of the earth is constant but in the study region rainfall is increasing.

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The highest rainfall receiving stations Mahabaleshwar and Amboli have shown decreasing trend of rainfall in all season. The catchment area of Mulshi, Pavna, Panshet, Dhom, Balkavadi, Koyana, Chandoli dam has shown decreasing trend its alarming situation for Krishna valley. The decreasing trend of rainfall over the Sahyadri is warning situation for the agriculture, availability of water resources and indicator of future droughts. Pune city, Pimpri Chinchwad city, Satara cities have to face water scarcity in future. Bhira [Raigad] shown decreasing trend of rainfall and recorded highest temperature in Maharashtra. It is interesting and significant changes in the rainfall pattern of Sahyadri have observed at regional level.

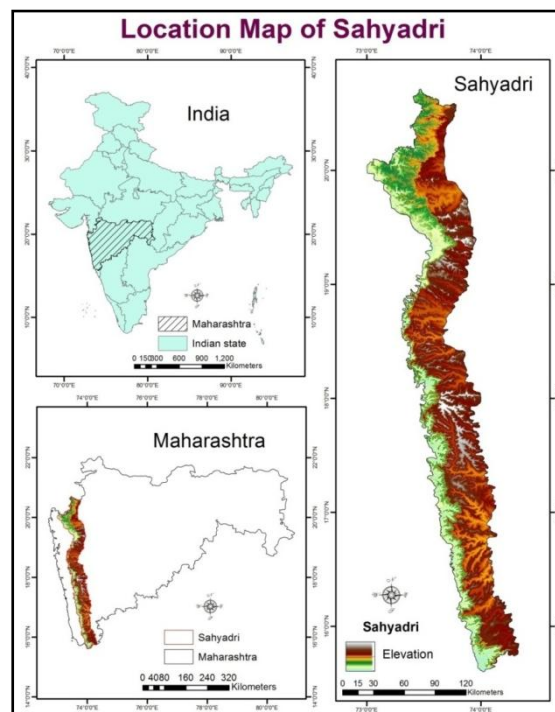


Figure 01:- Study Area

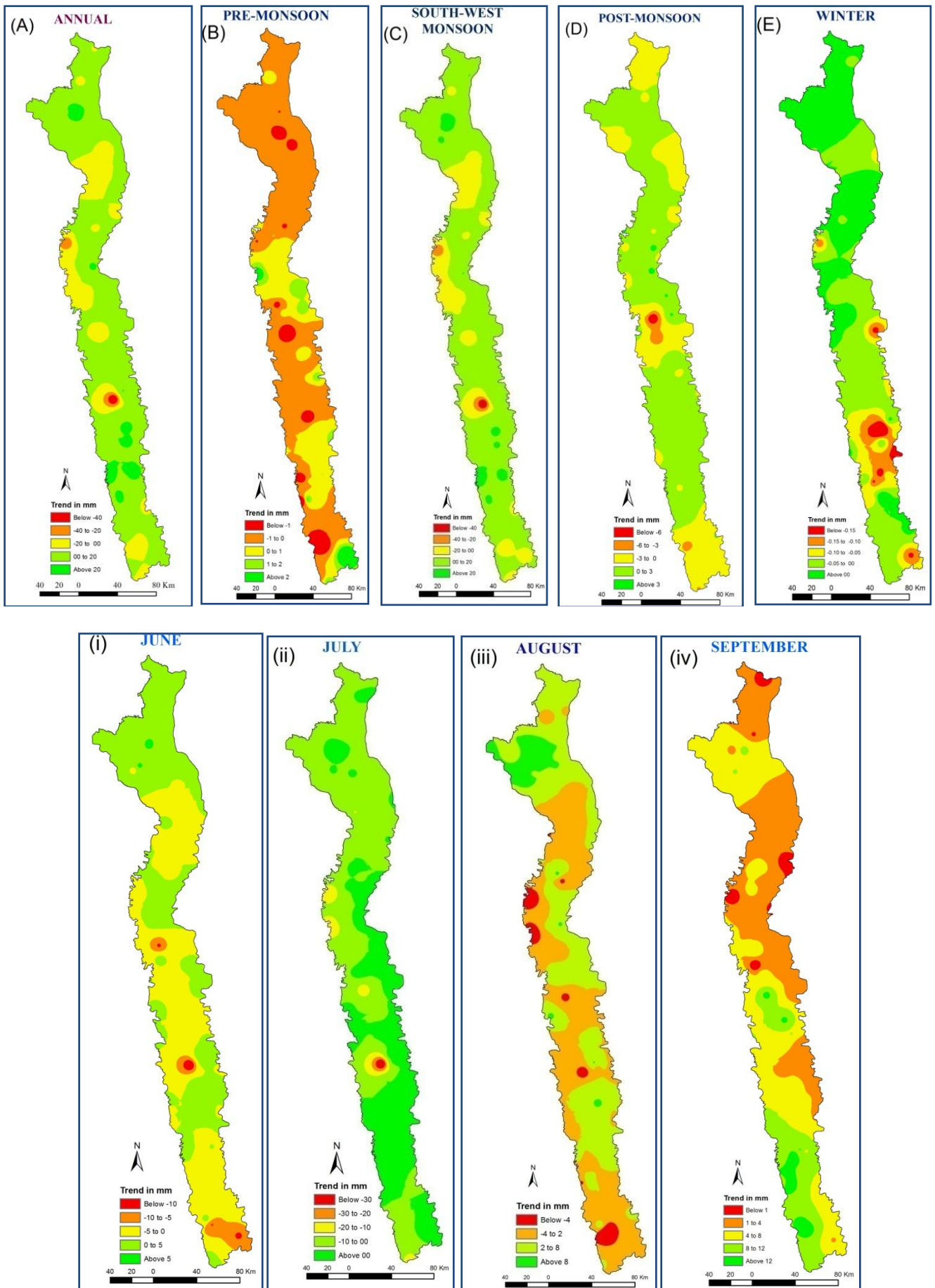


Figure 02(A,B,C,D,E and i, ii, iii, iv)