ISSN: 2278-4632
Vol-10 Issue-5 No. 12 May 2020

An Overview of Temperature and Rainfall Trends in Maharashtra: A Regional Approach

Dr. Sunita Maral,
Assistant Professor
Mithibai College (Autonomous) Vile Parle, Mumbai 400 056

ABSTRACT

Trends in regional series of maximum and minimum temperatures and seasonal rainfall of Maharashtra over a period of 56 years have been assessed using temperature and rainfall data of 21 meteorological stations. Regional series of temperature and rainfall derived using two methods, viz. spatial aggregation method or grid (spatial aggregation) method and simple averaging methods have been compared. Mann–Kendall trend test and the Sen's slope method have been used to detect the significance and the magnitude of temperature and rainfall trends.

Key words: maximum and minimum temperatures, seasonal rainfall, Maharashtra, regional series, spatial aggregation method, simple averaging method

Introduction

The present paper attempts to obtain an overview of climate of Maharashtra for the period 1951–2006. A regional series of maximum and minimum temperatures and seasonal rainfall of Maharashtra have been obtained and examined for presence of significant trends.

Study Area

The study area is the State of Maharashtra in India. Geographically Maharashtra is located between latitude $15^0$50'17" N to $22^0$12'52" N and longitude $72^0$35'26" E to $80^0$53'9" E and covers a total area of 308,000 sq.km.

Data

The data consists of mean monthly maximum and minimum temperatures and mean monthly rainfall for 21 stations of Maharashtra obtained from India Meteorological Department (IMD), Pune for the period 1951-2006. The stations having availability of minimum 80% data and less than 10% missing values in the period 1961-90 (WMO reference period) have been considered for the present study.

The analysis of the temperature and rainfall series of Maharashtra was carried out by dividing the state into four meteorological (met) sub-divisions, viz. Konkan (Alibag, Dahanu, Harnai, Mumbai, and Ratnagiri), Madhya Maharashtra (Ahmednagar, Jalgaon, Jeur,

ISSN: 2278-4632
Vol-10 Issue-5 No. 12 May 2020

Kolhapur, Malegaon, Pune and Solapur), Marathwada (Aurangabad, Parbhani) and Vidarbha (Akola, Amravati, Buldhana, Chandrapur, Gondia, Nagpur and Yeotmal).

Methodology

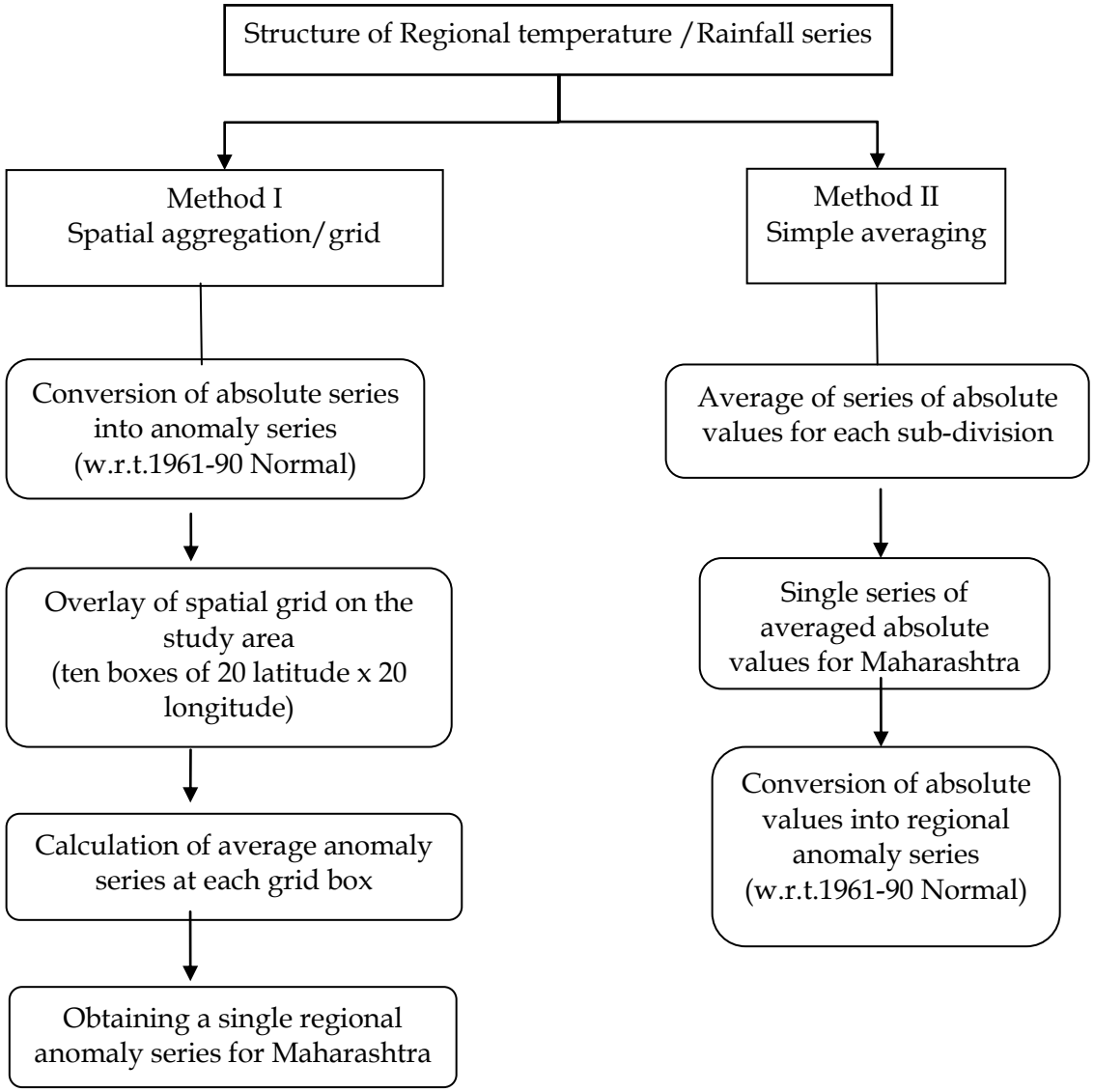
The temperature and rainfall series of 21 selected stations were subjected to quality control.

i. The outliers were identified and treated as missing and later filled with the help of reference series.

ii. Standard Normal Homogeneity Test (SNHT) was run for all the stations. In-homogeneities detected in isolated month and in-homogeneities in less than six months were not adjusted. In-homogeneities were not present throughout all 12 months in case of series tested for in-homogeneities.

iii. Reference station method has been used for filling the missing data values of a station.

Fig 1 Schematic Model of Methodology Followed for Generation of Regional Temperature and Rainfall Series of Maharashtra



ISSN: 2278-4632
Vol-10 Issue-5 No. 12 May 2020

Spatial Aggregation/grid method consists of constructing a regional series of a climatic variable by superimposing a spatial grid over an area. While Gray (2000), Brazdil et al (2001), Galan et al., (2001) have used grid method, Walker (1924); Parthasarathy and Dhar (1974); Pareek and Ramaswamy (1976) and Parthasarathy and Mooley (1978), Shukla (1987) have used area weighted means to derive regional series.

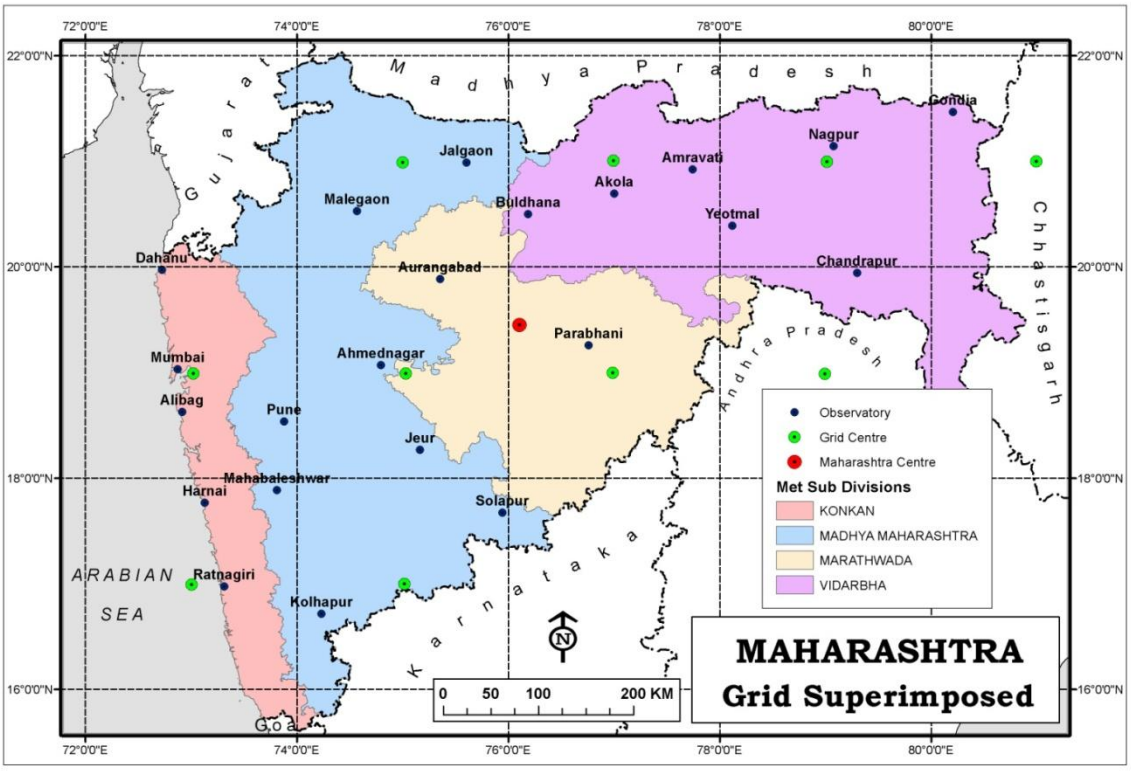
The regional temperature/rainfall series is calculated by applying the weighted algorithm described by Jones et al. (1986) in his spatial aggregation method:

$$A_g = \sum_{s=1}^{N} d_s A_s \Big/ \sum_{s=1}^{N} d_s \qquad \text{(Galan et al., 2001)}$$

Where: A_g is the interpolated temperature/rainfall anomaly for each grid point, A_s (s = 1, N) is the temperature/rainfall anomaly of the station, d_s is the inverse distance between station "s" and the grid point. Given the fact that the number of stations varies with time and between grid boxes, the cases in which N=1, the station values have been used as the corresponding grid point values.

For the calculation of spatial averages for the study area as a whole, the spatial averages of each network grid point are similarly weighted.

Map 1.1 Location of the Meteorological Stations and Grid used for obtaining the Maharashtra Regional Series of Temperature and Rainfall



Fig

ISSN: 2278-4632
Vol-10 Issue-5 No. 12 May 2020

Source: Survey of India Topographical sheet

Man-Kendall Test and Sen's Slope Estimator

Mann Kendall, a non-parametric test has been used here for detecting the significant trends in the time series of mean monthly maximum and minimum temperatures and seasonal rainfall of Maharashtra. According to this test, the null hypothesis H_0 assumes that there is no trend (data are independent and randomly ordered) and this is tested against the alternative hypothesis H_1, which assumes that there is a trend.

Theil–Sen estimator, also known as Sen's slope estimator, an unbiased estimator of the true slope in simple linear regression been used to calculate trends. Data were processed using an Excel macro named MAKESENS created by Finnish Meteorological Institute (2002)

The results and findings:

Maharashtra Regional Series - Trends in Seasonal and Annual Temperature

The regional anomaly series of maximum and minimum temperatures for four seasons (winter, summer, monsoon and post-monsoon) and year obtained by using two methods - 'grid or spatial aggregation' and 'simple averaging' - were compared and the differences between the series were found to be small.

It is evident from the Table 1 that statistically significant increasing trends are shown by post-monsoon and annual maximum regional series of temperature of Maharashtra obtained using 'simple averaging method'. The regional series of summer minimum temperature calculated using 'simple averaging method' shows a statistically significant decreasing trend. Annual minimum and other seasonal temperature series do not exhibit significant trends.

Table 1 Maharashtra - Linear Trends in Temperature

Maximum Temp			**Minimum Temp**		
	Decadal Trends (grid method)	Decadal Trends (averaging method)		Decadal Trends (grid method)	Decadal Trends (averaging method)
Winter	0.03	0.02	Winter	0.05	0.03
Summer	0.09	0.07	Summer	-0.05	-0.09*
Monsoon	0.00	0.03	Monsoon	0.03	0.00
Post-monsoon	0.10	0.12*	Post-monsoon	0.13	0.14
Annual	0.04	0.07*	Annual	0.03	0.00

ISSN: 2278-4632
Vol-10 Issue-5 No. 12 May 2020

For the four tested significance levels the following symbols have been used:

**** for $p < 0.001$; ** for $p < 0.01$; * for $p < 0.05$; + for $p < 0.1$; n.s. for $p \geq 0.1$*

Trends in Seasonal Rainfall of Maharashtra

The regional rainfall series for four months (June, July, August, September) and the seasonal rainfall series (average of the four months) of Maharashtra were calculated using both the methods; the Spatial Aggregation/grid method and the simple averaging method. The regional rainfall series of Maharashtra obtained using two different methods mentioned above showed noticeable differences unlike regional temperature series of Maharashtra.

Table 2 Maharashtra - Linear Trends in Seasonal Rainfall

Time series	Decadal Trends (grid method)	Decadal Trends (averaging method)
June	2.66	1.50
July	-3.42	-9.37*
August	0.12	5.13
September	-1.75	-1.85
Seasonal	-1.25	-2.92

** for $p < 0.05$*

The regional anomaly series of seasonal and four month's rainfall of Maharashtra obtained using grid method as well as simple averaging method do not exhibit statistically significant trends except July month. A statistically significant negative trend is evident in July rainfall series calculated by average method. No significant trend is evident in rainfall of other months.

Conclusion

Researchers have been using both the methods viz. spatial aggregation or grid method and simple averaging methods for obtaining regional series of temperature/rainfall. However, I believe grid method to be more appropriate than simple averaging method as it is based on weighted spatial averages. The findings based on grid method suggest that there is no significant rise or decline in the temperature and rainfall of Maharashtra over the study period.

Acknowledgement

The present study is based on the climate data obtained from National Data Centre, Pune. I am thankful to Dr. (Mrs.) Tapati Mukhopadhyay, Emeritus Fellow for her valuable guidance.

ISSN: 2278-4632
Vol-10 Issue-5 No. 12 May 2020

References

1. Bradzil R, Stepanek P and Kveton V (2001): Temperature Series of the Czec Republic and its Relation to Northern Hemisphere Temperatures in the period 1961-1999. In Manola Brunet India and Diego Lopez Bonillo (Eds.) - Detecting and Modelling Regional Climate Change. (pp. 69-80) Springer-Verlag Berlin Heidelberg New York.
2. Galan E., Canada R., Fernandez F. and Cervera B. (2001): Annual Temperature Evolution in the Southern Plateau of Spain from the Construction of Regional Climatic Time Series. In Manola Brunet India and Diego Lopez Bonillo (Eds) - Detecting and Modelling Regional Climate Change. (pp. 119-131) Springer-Verlag Berlin Heidelberg New York.
3. Labajo J.L. and Piorno A. (2001) Regionalisation of Precipitation in Castilla and Leon (Spain). In Manola Brunet India and Diego Lopez Bonillo (Eds) - Detecting and Modelling Regional Climate Change. (Pp.100-118) Springer-Verlag Berlin Heidelberg New York.
4. Shukla J. (1987): Interannual Variability of Monsoons. In Fein J.S. and Stephens Pamela L. (Eds.): Monsoons. A Wiley Interscience Pub. John Wiley & Sons.
5. Rathore L S, Attri S D and Jaswal A K (2013) 'State Level Climate Change Trends in India' under the Meteorological Monograph No. ESSO/IMD/EMRC/02/2013 India Meteorological Department, Ministry of Earth Sciences Government of India

