

Chapter 7

Summery and Conclusion

7.0 Overview

The present study of comparative Studies on Temperature and Rainfall Trends of Nanded and Parbhani cities of Marathwada region of Maharashtra we have analyzed temperature and rainfall of Nanded and Parbhani and come to the following conclusion. The details of summery and conclusions are drawn after the long statistical investigation of five years from the study area. They are as follows in details.

7.1 Comparison of Annual Maximum Temperature Trends

Annual maximum temperature of Parbhani showed decreasing trends the maximum temperature decreased by $0.0042^{\circ}\text{C}/\text{year}$ and total

decrease observed was 0.1764°C . While Annual maximum temperature of Nanded showed decreasing trends, the maximum temperature decreased by $0.0151^{\circ}\text{C}/\text{year}$ and has total decrease was 0.6342°C .

ATmin of Parbhani showed significantly decreasing trends of $0.021^{\circ}\text{C}/\text{year}$ and has total decrease was 0.8820°C . While ATmin of Nanded showed increasing trends of about $0.0086^{\circ}\text{C}/\text{year}$ and total increased was 0.3612°C .

Annual mean temperature (ATmean) of Parbhani showed significantly decreasing trends ATmean decreased $0.0126^{\circ}\text{C}/\text{year}$ and has total decrease 0.5292°C While ATmean of Nanded showed insignificant decreasing trends the ATmean of Nanded decreased by $0.0002^{\circ}\text{C}/\text{year}$ and annual mean temperature has total increased by 0.084°C .

Annual diurnal temperature (ADurinal) of Parbhani showed slightly increasing trends the ADurinal was increased by $0.0168^{\circ}\text{C}/\text{year}$ and total increase was 0.7056°C . The mean of ADurinal of Parbhani for 1969 to 2010 was 13.40°C .

7.2 Comparison of Seasonal Maximum Temperature

WTmax of Parbhani decreased by $0.0139^{\circ}\text{C}/\text{year}$ and total decrease was 0.5838°C . WTmax of Nanded showed decreasing trends the WTmax decreased by $0.0039^{\circ}\text{C}/\text{year}$ and total decrease was 0.1638°C .

The linear trends of summer mean maximum temperature (STmax) of Parbhani showed significantly decreasing trends. The linear trends of STmax of Nanded showed significantly decreasing trends. STmax of Nanded decreased by $0.0379^{\circ}\text{C}/\text{year}$. Total decrease was 1.5918°C . STmax of Parbhani decreased by $0.0225^{\circ}\text{C}/\text{year}$. Total decrease was 0.9450°C .

The linear trends of monsoon mean maximum temperature (MoTmax) showed decreasing trends. It decreased by $0.0035^{\circ}\text{C}/\text{year}$. Total decrease was 0.1470°C . The linear trends of MoTmax of Nanded showed decreased trends. It decreased by $0.0225^{\circ}\text{C}/\text{year}$. Total decrease was 0.9450°C .

The linear trends of post monsoon mean maximum temperature (PMTmax) of Parbhani showed significantly increasing trends. It increased by $0.0216^{\circ}\text{C}/\text{year}$. Total increase was 0.9072°C . The linear trends of PMTmax of Nanded showed significantly increasing trends. It increased by $0.0097^{\circ}\text{C}/\text{year}$. Total increase was 0.4074°C .

7.3 Comparison of Seasonal Minimum Temperature

The linear trends of winter mean minimum temperature (WTmin) of Parbhani showed significantly decreasing trends the WTmin decreased by $0.0399^{\circ}\text{C}/\text{year}$ and total decrease was 1.6758°C . The linear trends of WTmin of Nanded showed significantly decreasing trends WTmin decreased by $0.0089^{\circ}\text{C}/\text{year}$ and has total decrease was 0.3738°C .

The linear trends of summer mean minimum temperature (STmin) of Parbhani showed significantly decreasing trends. STmin of Parbhani decreased by $0.0269^{\circ}\text{C}/\text{year}$. Total decrease was 1.1298°C . The linear trends of STmin of Nanded show decreased trends. STmin of Nanded decreased by $0.0149^{\circ}\text{C}/\text{year}$. Total decrease was 0.6258°C .

The linear trends of monsoon mean minimum temperature (MoTmin) showed significantly increasing trends. It increased by $0.0061^{\circ}\text{C}/\text{year}$. Total increase was 0.2562°C . The linear trends of MoTmin of Nanded showed significantly increasing trends. It increased by $0.0167^{\circ}\text{C}/\text{year}$. Total increase was 0.7014°C .

The linear trends of post monsoon mean minimum temperature (PMTmin) showed significantly decreasing trends. It decreased by $0.0180^{\circ}\text{C}/\text{year}$. While the linear trends of PMTmin of Nanded showed significantly increasing trends. It increased by $0.0184^{\circ}\text{C}/\text{year}$. Total increase was 0.7728°C .

7.4 Comparison of Seasonal Mean Temperature

The linear trends of winter mean of mean temperature of Parbhani (WTmean) showed decreasing trends the WTmean decreased by $0.0273^{\circ}\text{C}/\text{year}$ and total decrease was 1.147°C . WTmean of Nanded

showed slightly decreasing trends the winter mean of mean temperature decreased by $0.0063^{\circ}\text{C}/\text{year}$ and total decrease was 0.2646°C .

The linear trends of summer mean of mean temperature (STmean) of Parbhani showed significantly decreasing trends. STmean of Parbhani decreased by $0.0247^{\circ}\text{C} / \text{year}$. Total decrease was 1.037°C . The linear trends of STmean of Nanded showed decreased trends. STmean of Nanded decreased by $0.0256^{\circ}\text{C}/\text{year}$. Total decrease was 1.0752°C .

The linear trends of monsoon mean of mean temperature (MoTmin) showed slightly decreasing trends. It decreased by $0.0071^{\circ}\text{C}/\text{year}$. Total decrease was 0.2980°C . The linear trends of MoTmin of Nanded showed decreased trends. It decreased by $0.0025^{\circ}\text{C}/\text{year}$. Total increase was 0.1050°C .

The linear trends of post monsoon mean of mean temperature (PMTmean) of Parbhani showed slightly increasing trends. It increased by $0.0021^{\circ}\text{C}/\text{year}$. Total increase was 0.0882°C . The linear trends of PMTmean of Nanded show increasing trends. It increased by $0.0192^{\circ}\text{C}/\text{year}$. Total increase was 0.8064°C .

7.5 Comparison of Monthly Maximum Temperature

The linear trends monthly mean of maximum temperature (MTmax) was decreased for the month January, March, march, April, may, July, August September and increased for the month June, October, November December.

Highest decrease in monthly maximum temperature (m Tmax) occurs in March (0.0310°C) per year and has decreased by 1.302°C . While highest increase in mean monthly maximum temperature occurs in December (0.0304°C) and has increased by 1.2768°C .

Linear trends of MTmax of Nanded was decreased for the month January, March, march, April, may, June, July, September, October, December and increased for the month September, November Highest decrease in monthly maximum temperature occurs in May (0.0449°C) per year and has decreased by 1.7511°C . While highest increase in

mean monthly maximum temperature occurs in November (0.0350°C) and has increased by 1.3650°C .

7.6 Comparison of Monthly Minimum Temperature

For Parbhani Monthly mean of minimum temperature have decreased for the months January, March, March, April, May, July, September, September, October, December and increased for the month June, July, November. Highest decrease in monthly minimum temperature occurs in March (0.0442°C) per year and has decreased by 1.8564°C . While highest increase in mean monthly minimum temperature occurs in July (0.0130) and has increased by 0.5460°C .

For Nanded monthly mean of minimum temperature have decreased for the month January, March, march, and increased for the month January, June, July, April, may, July, September, September, October, December, November. Highest decrease in monthly minimum temperature occurs in March (-0.0232) per year and has decreased by 0.9048°C . While highest increase in mean monthly minimum temperature occurs in July and September (0.0397) and has increased by 1.5483°C .

7.7 Comparison of Monthly Mean Temperature

The monthly mean of mean temperature of Parbhani has decreased for the month January, March, march, April, may, July, September, September and October and increased for the month June, November December. Highest decrease in monthly mean temperature occurs in March $0.0361^{\circ}\text{C}/\text{year}$ and has decreased by 1.5160°C . While highest increase in mean monthly mean temperature occurs in November (0.0159) and has increased by 0.6680°C .

The MTmean of Nanded February, March, April, May, June, July, September October showed decreasing trends and MTmean of January, August, November and December show increasing trends. Highest decrease in monthly mean temperature occurs in May $0.0339^{\circ}\text{C} /\text{year}$ and total decrease observed was 1.4238°C . While highest increase in

MTmean occurs in November and it was $0.393^{\circ}\text{C}/\text{year}$ and total increase was 1.6503°C .

7.8 Comparison of Daily Maximum Temperature

The Most of the daily maximum temperature (dTmax) of Parbhani shows decreasing trends out of 365 days 197 (53.97%) days show decreasing trends and 167 (45.76%) days show upward trends (figure 4.54). Maximum decreasing trends was observed on 28th July and it was $0.109^{\circ}\text{C}/\text{year}$ and for the period of 42 years it was 4.578°C . Out of 365 days 167 (45.75%) days show increasing trends (figure 4.53) of dTmax Maximum upward trends was noticed on 28th December and it was $0.069^{\circ}\text{C}/\text{year}$ and for total period of 42 year it was 2.898°C . While dTmax of 5th December does not shows any trends.

Most of the (dTmax) of Nanded shows decreasing trends out of 365 days 218 (59.73%) days show decreasing trends. Maximum decreasing trends was observed on 8th May and it was $0.151^{\circ}\text{C}/\text{year}$ and for the period of 42 years it was 5.889°C . Out of 365 days 144 days show increasing trends Maximum upward trends were noticed for 2nd June and it was $0.109^{\circ}\text{C}/\text{year}$ and for total period of 42 year it was 4.251°C . While daily Maximum temperature of 27th April, 14th September, 28th December does not show any trends.

Mean of daily maximum temperature (dTmax) of Parbhani and Nanded. From figure (4.55), it was evident that Maximum (dTmax) was observed in May. dTmax of January, December and February show minimum dTmax. Minimum dTmax was observed on 29th December and it was 28.50°C . dTmax of March, April, and May was characterized by maximum temperature Maximum dTmax was observed on 11th of May and it was 42.40°C . Maximum coefficient of variation was observed on 17th June and it was 10.330 and minimum coefficient of variation was observed on 1st April and it was 3.381. This means that daily maximum temperature was more stable on 1st April and more varied on 17th June.

For Nanded dTmax of January, December and February show Minimum maximum temperature. Minimum dTmax was observed on 31st December and it was 27.10°C. dTmax of March, April, and May was characterized by maximum temperature Maximum dTmax was observed on 27th April and it was 42.20 °C. Maximum coefficient of variation was observed on 16th June and it was 11.20 and minimum coefficient of variation was observed on 10th April and it was 2.50 .This means that daily maximum temperature was more stable on 10th April and more varied on 16th June.

7.9 Comparison of Daily MinimumTemperature

Most of the daily minimum temperature (dTmin) of Parbhani shows decreasing trends out of 365 days 260 (71.23%) days show decreasing trends. Maximum decreasing trends was observed on 26th January and it was 0.112°C/year and for the period of 42 year it was 4.70°C Out of 365 days 93 (25.47%) Maximum increasing trends was observed on 10th November and it was 0.052°C/year and for the period of 42 years it was 2.180°C. Maximum decrease was observed on 28th July. While dTmin of 12 (3.28%) days show no trends dTmin 6th,22nd January, 3rd,20th March, 30rd April, 4th,8th 24th may, 16th August, 6th, 9th, 10th September does not show any trends.

Most of the daily minimum temperature (dTmin) of Nanded shows increasing trends out of 365 days 253 (69.32%) days show increasing trends. Maximum increasing trends was observed on 29th December and it was 0.193°C/year and for the period of 42 years it was 7.527°C. Out of 365 days 106 days show decreasing trends Maximum downward trends was noticed for 19th February and it was 0.101°C /year and for total period of 42 year it was 3.939°C. While daily minimum temperature (dTmin) of 6(1.65%) days shows no trends which are 8th January, 12th February, 17th March, 6th, 19th and 21st September.

it was evident that Maximum (dTmin) was observed in April and May. Maximum dTmin was observed on 27th December and it was 27.30°C.

dTmin of January, December and February showed Minimum dTmin. Minimum dTmin was observed on 29th December and it was 12.50°C. Maximum coefficient of variation was observed on 27th December and it was 27.26 and minimum coefficient of variation was observed on 12th August and it was 2.975. This means that daily minimum temperature was more stable on 12th August and more varied on 27th December.

The dTmin of January, December and February show Minimum dTmin Minimum dTmin was observed on 31st December and it was 10.61°C. dTmin of March, April, and May was characterized by maximum temperature Maximum dTmin was observed on 31st May and it was 25.90 °C. Maximum coefficient of variation was observed on 31st May and it was 28.537 and minimum coefficient of variation was observed on 31st December and it was 3.773 .This means that daily minimum temperature (dTmin) was more stable on 31st December and more varied on 31st May.

7.10 Comparison of Extremes of Temperature

For Parbhani total 59 heat waves were observed for the given period of 42 years and maximum 10 heat waves were observed in 2010. For Nanded total 39 heat waves were observed for the given period of 42 years. Maximum heat waves were observed in 1973 and it were 12.

For Parbhani linear trends of hot waves showed slightly decreasing trends. It decreased by 0.1001/year and total decrease was 4.20. For Parbhani near about 51 hot days/ years were found. Maximum 76 hot days was noticed in the year 1992 and minimum 25 hot days were noticed in 1990. For Nanded linear trends of hot waves showed decreasing trends. It decreased by 0.5725/year and total decrease was 24.045. For Nanded near about 52 hot days/ years were found.

For Parbhani total 198 cold waves were observed for the given period of 42 years. For Parbhani near about 4.7 cold waves/ years were found. Maximum 21 cold waves were observed in 1999, while no cold was noticed in 1973.

For Nanded total 451 cold waves were observed for the given period of 42 years. Maximum cold waves were observed in 1983 and it was 53 while no cold was noticed in 1983. For Nanded near about 10.8 cold waves/ years were found.

7.11 Comparison of Annual Rainfall Trends

Long-term annual rainfall trends over Parbhani showed significantly increasing trends for the period of 42 years. Increase of about 0.5529 mm/year was observed and total increase was 23.22 mm. Long-term annual rainfall trends over Nanded showed decreasing trends for the period of 42 years. Decrease of about 0.3545 mm/year was observed and total decrease was 14.90 mm. The mean annual rainfall for Nanded for the period of 42 years was 877 mm.

7.12 Comparison of Seasonal Rainfall Trends

Long-term seasonal rainfall of winter over Parbhani showed slightly increasing trends. The rainfall increased by 0.0454/year and total increase for this period was 1.90 mm. Long-term seasonal rainfalls of winter over Nanded showed decreasing trends. The rainfall decreased by 0.1743/year and total decrease for this period was 7.30 mm.

Long-term seasonal rainfall of summer over Parbhani showed slightly increasing trends. The rainfall increased by 0.5733/year and total increase for this period was 24.08mm. For Nanded long-term summer rainfall of showed decreasing trends. The rainfall decreased by 0.173/year and total decrease for this period was 7.30 mm.

Long-term monsoon rainfall trends over Parbhani show slightly decreasing trends. The rainfall decreased by 0.462 mm/year and total decrease for this period was 19.404mm. Monsoon rainfalls over Nanded increased by 387.20 mm/decade and total increase for the period of 42 years was 1548.90 mm.

Long-term seasonal rainfall over Parbhani of post-monsoon showed increasing trends. The post monsoon rainfall increased by 0.3564/year and total increase for this period was 14.90 mm. For

Nanded long-term post monsoon rainfalls show decreased trends. The rainfall increased by 0.7097 mm/year and total decrease for this period was 29.70 mm.

7.13 Comparison of Monthly Rainfall Trends

For Parbhani monthly rainfall trends of February, May, June, August, September showed decreasing trends. Maximum fall was seen for the month of August and it was 2.86mm/year and total fall for the period of 42 year was 120.40 mm.

For Nanded maximum decrease was seen for September and it was 2.4253mm/year and total decrease for the period of 42 year was 94.59mm. April, June, July, August, and December show increasing rainfall trends. Maximum increase was seen for the month of December and it was 5.8261mm/year and total fall for the period of 42 year was 227.22 mm.

7.14 Comparison of Daily Rainfall Trends

For Parbhani out of 122 day of monsoon season near about (61) 50.15% days show upward daily rainfall trends and 60 (49.18%) days showed downward trends. Maximum increasing trends of daily rainfall was observed for 25th July. For this day rainfall has increased 1.3732 mm/year and total rise was 57.67 mm for the period of 42 years.

Maximum fall was seen for 1st September daily rainfall decreased by 0.5399 mm/year total fall of 22.64 mm was noticed for the period of 42 years. While linear trends of daily rainfall of 4th June does not show any trends.

For Nanded out of 122 day of monsoon season near about (50 days) 41 % days show upward daily rainfall trends and (72 days) 59% days show downward trends. Maximum increasing trend for daily rainfall was seen for 4th August. For this day rainfall was increased 0.548mm/year and total rise was 32.097 mm for the period of 42 years. Maximum fall was seen for 20th August daily rainfall decreased by 0.651 mm/year and total fall of 25.389 mm was noticed for the period of 42 years.

7.15 Analysis of Extreme Rainfall Events

During the study period of 42 years 2325 rainy days were witnessed over Parbhani . Out of 2325 rainy days 1921(82.62%) rainy days were witnessed in monsoon season and only 404 (17.38%) rainy days witnessed in summer and winter and post monsoon season.

During the study period of 42 years 2184 rainy days were witnessed in Nanded. Out of 2184 rainy days 1816 (83.15%) rainy days were witnessed in monsoon season and 368 (16.85%) rainy days witnessed in summer and winter and post monsoon season.

7.16 Comparison of Rainy Days Trends

Parbhani showed total 82 extreme rainfall day events for given period of 42 years. Heavy rainfall day (day having rainfall <64.5 mm) 09 days were observed showing very heavy rainfall ((i.e. rainfall 124.5mm to 244.5mm) and 1 day showing very extreme heavy rainfall (i.e. greater than 244.5mm).

Nanded showed total only 60 heavy rainfall days for given period of 42 years. Maximum 7 heavy rainfall days were noticed in the year 2007. For Nanded linear trends of frequency of extreme rainfall events showed increasing trends. For Nanded 15 days were observed showing very heavy rainfall (i.e. 124.5mm to 244.5mm) and 6 day showing very extreme heavy rainfall (i.e. greater than 244.5mm).

From above summery it is evident that annual, seasonal, monthly, daily temperature and rainfall trends of Parbhani and Nanded get changed. This change in temperature and rainfall varies according to time and space. This is because the rate of urbanization is different in different places.

The rate of urbanization of Parbhani is less than that of Nanded as follows. In 1971 the population of Parbhani was 108987 and in 2011 it reached to 307170. The rate of increase was 53182/decade. The population of Nanded in 1971 was 126518 and in 2011 it reached to 550439. The rate of increase in population of Nanded was 108731/decade which is double than that of Parbhani.

The rate of increase in vehicular burden for Parbhani was 19920/decade. The number of vehicles of Nanded in 1971 was 2089 and in 2010 it reached to 98769 the rate of increase in vehicular burden for Nanded was 25182/ decade which is more than that of Parbhani.

Parbhani in 1973 there was 0.27 % of water body, in 1990 it increases to 0.34% and later in 2010 it decreased to 0.24%. In 1973 the vegetation cover was 48.89% in 1990 it decreased to 46.94% and in 2010 it decreased to 39.26%. The rate of decrease was 2.408%/ decade and total 9.630 % decrease was observed.

In 1973 the percentage of settlement was 5.32% in 1990 it increased to 7.34% and in 2010 it became 14.45%. The settlement in Parbhani is increased at a rate of 2.283/decade and total decreased 8.972 % was observed. Decrease in vegetation is due to increase in settlement.

For Nanded in 1973 there was 2.3% of water body in 1990 it reduced to 1.8% and later in 2010 it declined to 2.3%. In 1973 the vegetation cover was 29.9% in 1990 it improved to 31.40% and in 2010 it shrank to 17.10%.The rate of decline was 4.187% /decade and total reduction of 12.321 % was detected.

In 1973 the percentage of settlement was 16.42% in 1990 it increased to 19.34% and in 2010 it became 33.085%. The settlement in Parbhani is increased at a rate of 4.683 % decade and total decreased 8.972 % was observed. Decrease in vegetation is due to rise in settlement.

7.2 Resume

The present chapter is mainly deals with investigation of Comparative Studies on Temperature and Rainfall Trends of Nanded and Parbhani cities of Maharashtra state and different factor affecting these trends. The details of summery and conclusions are given in this chapter after the long statistical investigation.

In addition to these, arrangement of text of reference and annexures has been mentioned in eight and nine chapter respectively.

7.3 Concluding Remark

The Annual, seasonal, monthly, daily temperature trends and Annual, seasonal, monthly, daily rainfall trends get changed. The rate of change in these trends are different at Parbhani and Nanded.

7.4 Hypothesis Recheck

The climatic parameters like temperature and rainfall have spatio-temporal significances in their changing nature. It means some annual, seasonal, monthly and daily temperature and rainfall trends variations were observed with different trends at the two selected places (i.e. Parbhani and Nanded), which are associated with local (anthropological and natural reasons) changes.

7.5 Objective Covered

1. To understand the geographical parameters of the study area.

This objective is thoroughly discussed in 2nd and 6th chapter.

2. To analyze the available climatic data with proper statistical methods and geographical models.

This objective is thoroughly covered in 3rd, 4th, 5th and 6th chapter.

3. To identify center-wise micro leveled changes in the trends and periodicities of temperature and rainfall.

This objective is thoroughly enclosed in 4th and 5th chapter

4. To evaluate the extreme situations of temperature and rainfall observed in the past.

This objective is thoroughly exposed in 4th, and 5th chapter

5. To recognize the local geographical reasons responsible for the changes or fluctuations in these trends.

This objective is thoroughly enclosed in 2nd and 6th chapter.

6. To try for design of simplest way for prediction of the selected climatic parameters.

This objective is thoroughly covered in 6th chapter.

