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ANALYSIS OF MONTHLY AND SEASONAL TEMPERATURE TRENDS OF NANDED

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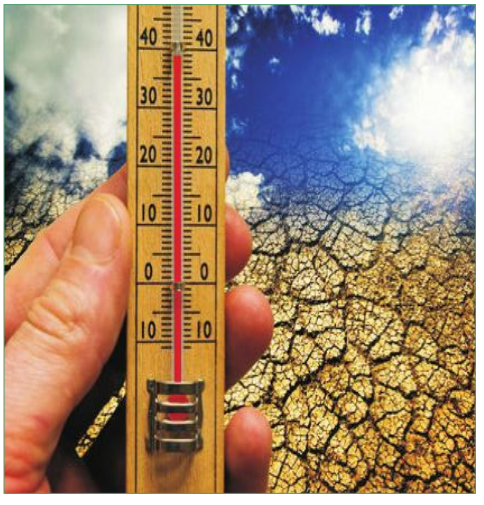
ABSTRACT

The trend of monthly, seasonal mean of maximum, minimum, mean temperature and seasonal temperature data wereassessed for metrological data of Nanded of Maharashtra for the year 1969-2007. Most of the mean monthly maximum temperature (Tmax) show



downward trends and most of the seasonal Tmaxdisplays upward trends by linear regression method. For Nandedmean monthly maximum temperature of May shows highest fall in mean monthly maximum temperature and summer shows highest fall in seasonal mean maximum temperature. For monthly mean of minimum temperature most of the month and season shows upward trendsNovember shows highest increase in monthly mean of minimum temperature andmonsoon shows highest increase. For mean monthly mean temperature most of the months and season shows upward trends. Highest increase occurs in the month November and in post monsoon season.

KEYWORDS :*Monthly temperature, maximum, minimum temperature, linear trends.*

1.INTRODUCTION:

Loose urbanization has greatly enhanced commercial and social progress, and universal cities are devices of economic growth and centers of innovation for the global economy and the surroundings of their respective nations (De Sherbinin et al., 2007), but urbanization has also created numerous environmental problems ranging from the local to the global scale (Kim and Baik, 2005; Zhao

et al., 2006), including increased air and water pollution and decreased water supply (Liu and Diamond, 2005; Shao et al., 2006), local climate change and increased energy demands (Zhou et al., 2004; González et al.,2005). This statisticconcerned attention of scientist, climatologist, and researcher on global to regional scale. On overall scale most of the scientist (Nicholl, 1996; Jones , 1999; Liu and Chen, 2000;Alina Vladut, 2001; New , 2002; Xu, 2009; Mahyou, 2007;Jones P.D., 2007) and Intergovernmental panel on climate change (IPCC) established that there has been huge scale warming of the earth surface over the last hundred years.(IPCC,2001; IPCC2001b,).On regional scale in India many researcher (Jaswal, 2014;D.T.Deshmukh, 2013a; Karnewar and Kadam, 2014a; Chinchorkar, 2013; Deshmukh, 2013b; Karnewar and Kadam, 2014b; Hingane, 1985, Bhutiyan, 2007; Das, 2007;Jaswal, 2007; Shrivastav, 1992;Rupa Kumar , 1994;Sahai,1998; Jaswal, 2014) calculated temperature trends over India and informedgrowing trends in maximum and minimum temperature over India. Monthly mean temperature of India as a whole climbed to 0.51 ºC over a period of 1901-2005(Faulekar and Kale, 2007,).This rate of rise may fluctuate in different geographical regions (Deshmukh, 2013b) since this increase is linked with anthropological emission of greenhouse gases, change in land use pattern, increasing urbanization. Much other trait such as difference in solar radiation and pollutant aerosols also added to climate change (N.Scafetta, 2005; Brassuar, 2001).Karnewar and Kadam (2015) detected annual trends for Nanded and found upward trends. But according to Xuebin (2011) monthly mean provides useful and simple metrics that can be used to track relatively slow variation and trends. Taking all this fact in consideration this paper aims to study monthly and seasonal temperature trends of Nanded

2. STUDY AREA

Nanded is the second largest city in Marathwada division of Maharashtra located on the bank of Godavari, having elevation 362m above sea level. It is the headquarters of Nanded in the Marathwada. Nanded is part of Marathwada Region in Maharashtra. Nanded has a geographical area of 10,528 Sq. Km., which forms 3.41% of the total geographical area of Maharashtra State. The Nanded is situated in the Deccan Plateau. The of Nanded has between 18°.15' and19°.55' North latitude and 77°.7' to 78°.15' east longitudes

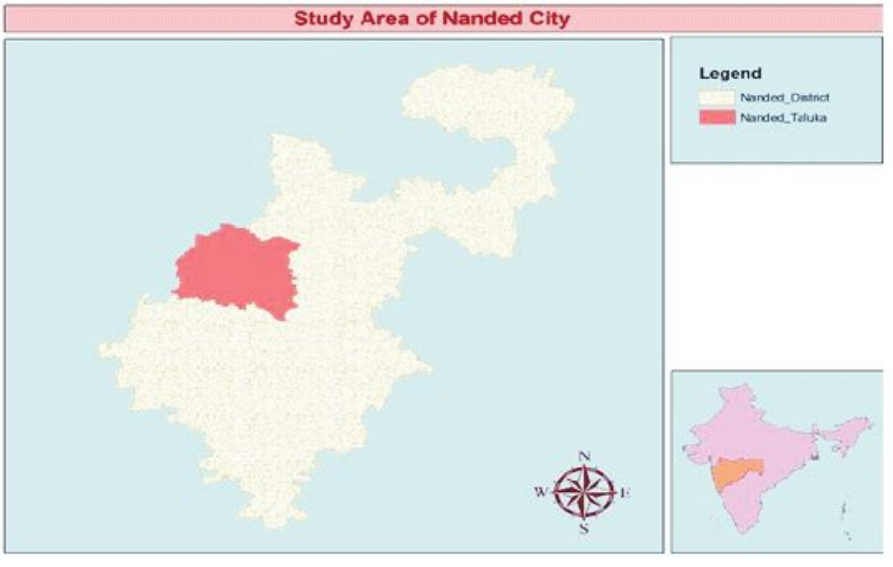


Figure: 1 showing study areas map of Nanded

3 .DATA AND METHODOLOGY

The daily temperature datanotedby IMD Pune for period 1969-2007 was collected. From daily time series data monthly maximum and monthly minimum and monthly mean temperatures were calculated. Then monthly mean of maximum temperature (Tmax), minimum temperature (Tmin), mean temperature (Tmean) were averaged to determine seasonal temperature. According to IMD, Meteorological seasons over India are: Winter Season: January, February. Summer Season: March, April, May. Monsoon Season: June July, August, September. Post Monsoon Season: October, November, December. Later on The statistical method such as correlation analysis, regression analysis and coefficient of determination and coefficient of variation are derived.

Trend is determined by the relation between the two variables as temperature and time. Trends is the general movement of a series over an extended period of time or it is long term change in the dependent variable over a long period of time (Webber and Hawkins, 1980)the statistical methods such as regression analysis and coefficient of determination r^2(Murray R.Spiegel,LarryJ.Stephens, 2000)are used

4. RESULT AND DISCUSSION

Table1.Statistical summary of monthly and seasonal mean of Tmax temperature during 1969-2007.for Nanded

Month.	mean	St. dev.	c.o.v.	c.o.d	Y	Trends	Total increased
Jan	30.83	1.035	3.400	0.00120	-0.0032x + 30.895	downward	-0.1248
Feb	33.24	1.726	5.200	0.00690	-0.0192x + 33.829	downward	-0.7488
Mar	37.28	1.387	3.700	0.07240	-0.0367x + 38.142	downward	-1.4313
Apr	40.76	0.812	2.000	0.06150	-0.0176x + 41.113	downward	-0.6864
May	41.23	1.471	3.600	0.12110	-0.0449x + 42.124	downward	-1.7511
Jun	36.79	2.120	5.800	0.01150	-0.02x + 37.191	downward	-0.7800
Jul	32.31	1.239	3.800	0.02530	-0.0173x + 32.652	downward	-0.6747
Aug	31.49	1.125	3.600	0.00210	0.0045x + 31.396	Upward	0.1755
Sep	32.26	1.202	3.700	0.00260	-0.0054x + 32.372	downward	-0.2106
Oct	32.89	1.221	3.700	0.00040	-0.0023x + 32.94	downward	-0.0897
Nov	31.22	0.940	3.000	0.01804	0.035x + 30.52	Upward	1.3650
Dec	29.78	0.810	2.700	0.00060	-0.0017x + 29.811	downward	-0.0663
Winter	32.03	1.085	3.400	0.0195	-0.0109x + 32.348	Upward	-0.4251
Summer	39.757	0.873	2.200	0.1019	-0.0184x + 40.214	downward	-0.7176
Monsoon	33.212	1.006	3.000	0.0060	0.0051x + 33.207	Upward	0.1989
Po. Mons.	31.332	0.802	2.600	0.057	0.0165x + 31.034	Upward	0.6435

The coefficient of variation for Tmax is highest in the month of February and it is observed as 5.200% whereas it is lowest in the month of April and it is witnessed 2.000% for Nanded. This means that maximum temperature is most stable in April and least stable in February for Nanded.For season the coefficient of variation for Tmax is highest in the winter and it is observed as 3.400% whereas it is lowest in the summer and it is observed 2.200% for Nanded. This means that maximum temperature is most stable in summer and least stable in winter for Nanded

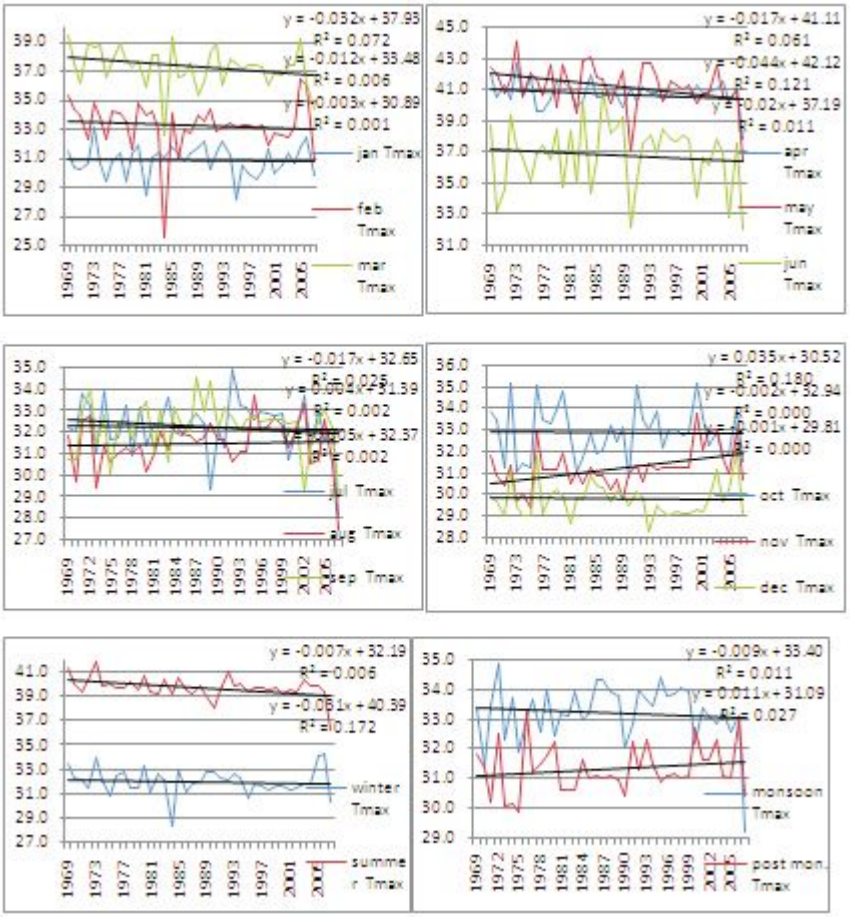


Figure 2 mean of maximum monthly and seasonal temperature of Nanded.

2.1. Trend Analysis of monthly and seasonal mean of Tmax of Nanded

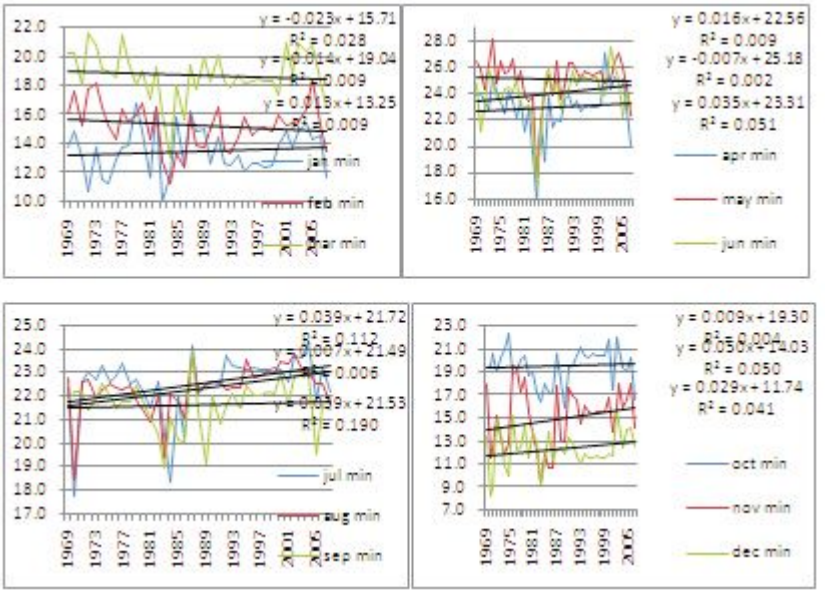
The trends of monthly mean of maximum temperature (Tmax) were obtained using linear regression best fit lines. The linear regression equations and coefficient of determination for all the months from January to December and for all the season from winter to post monsoon are represented in table 1 and summarized from figure 1.It is evident from above figure 2 and table 1. That monthly mean of maximum temperature (Tmax) of January, February, March, April, May, June, July, September, October, December shows downward trendsand total drop was0.1248^{0}C, 0.7488^{0}C, 1.4313^{0}C, 0.6864^{0}C, 1.7511^{0}C, 0.2106^{0}C, 0.0879^{0}C, respectivelyfor Nanded for 39 years. August and November shows upward trends and total increase 0.1755^{0}C, 1.3650^{0}C respectively for Nanded for the periods of 39 years.From above figure 2 it is clear that May shows highest fall in mean monthly maximum temperature and it was 1.7511^{0}C and month December shows highest increase and it was 1.276^{0}C for the period of 39 year.

The trends of seasonal mean maximum temperature(Tmax) of winter and summer shows downward trends and monsoon and post monsoon season shows increasing trends.Winter andsummershows fall in seasonal mean maximum temperature (Tmax) of 0.4251^{0}C, 0.7176^{0}C respectively for the periods of 39 years.Monsoon and Post monsoon shows upward trends of 0.1989^{0}C,0.6435^{0}Crespectively for the period of 39 years. Summer shows highest fall (0.7176^{0}C) while post monsoon shows highest increase(0.6435^{0}C) in seasonal mean maximum temperature.

Table.2 Statistical summary of monthly and seasonal mean of Tmin and during 1969-2007for Nanded

Month	Mean	St. dev.	c.o.v	c.o.d	Y	Trends	Total. Increase
Jan	13.53	1.5957	11.80	0.0091	0.0134x + 13.259	Upward	0.5226
Feb	15.25	1.5662	10.27	0.0286	-0.0232x + 15.716	downward	-0.9048
Mar	18.75	1.6902	9.020	0.0099	-0.0148x + 19.043	downward	-0.5772
Apr	22.90	1.9291	8.430	0.0094	0.0164x + 22.568	Upward	0.6396
May	25.04	1.7553	7.010	0.0022	0.0073x + 25.183	Upward	0.2847
Jun	24.03	1.7972	7.480	0.0513	0.0357x + 23.311	Upward	1.3923
Jul	22.52	1.3507	6.000	0.1122	0.0397x + 21.724	Upward	1.5483
Aug	22.33	1.0379	4.650	0.1905	0.0397x + 21.536	Upward	1.5482
Sep	21.65	1.0535	4.870	0.0069	0.0077x + 21.497	Upward	0.3003
Oct	19.49	1.5785	8.100	0.0044	0.0092x + 19.305	Upward	0.3588
Nov	15.04	2.5644	17.050	0.0501	0.0503x + 14.03	Upward	1.9617
Dec	12.34	1.6549	13.410	0.0412	0.0294x + 11.749	Upward	1.1466
winter	14.39	1.2900	9.000	0.0019	0.0049x + 14.488	Upward	0.1911
summer	22.23	1.6500	7.000	0.0002	-0.0061x +22.483	downward	-0.2379
monsoon	22.63	1.0800	5.000	0.1042	0.0307x + 22.017	Upward	1.1973
Post. Mons.	15.62	1.4900	10.000	0.0512	0.0297x + 15.028	Upward	1.1583

The coefficient of variation for Tmin is highest in the month of November and it is observed as 17.050% whereas it is lowest in the month of August and it is observed 4.650% for Nanded. This means that minimum temperature is most stable inAugust and least stable in November for Nanded. For season the coefficient of variation of Tmin is highest in the Post Monsoon and it is observed as 10.00 % whereas it is lowest in the Monsoon and it is observed 5.000 % for Nanded. This means that mean minimum temperature is most stable in Monsoon and least stable in Post monsoon for Nanded.



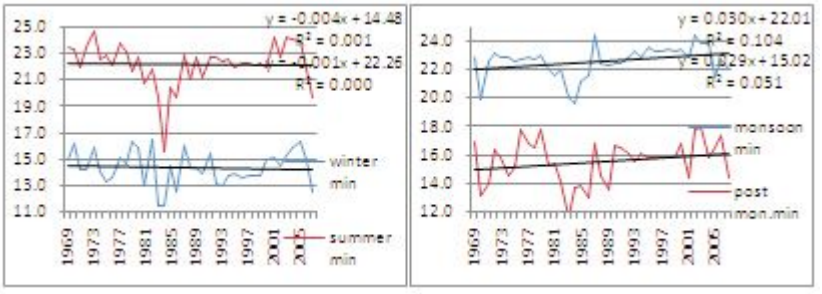


Figure 3 Mean of minimum monthly and seasonal temperature of Nanded

2. Trend Analysis of monthly and seasonal mean of Tmin of Nanded

The trends of monthly mean of minimum temperature (Tmin) were obtained using linear regression best fit lines. The linear regression equations and coefficient of determination for all the months from January to December and for all the season from winter to post monsoon are represented in table 2 and summarized from figure 3.It is evident from above figure 3 and table 2. That monthly mean of minimum temperature (Tmin) shows downward trends for the months of February and March and the total drop was 0.9048^{0}C, 0.5772^{0}C respectively for Nanded for 39 years and shows upward trends forJanuary,April, May,June, July,August, September,October, November, Decemberand The total increase was 0.5226^{0}C, 0.6396^{0}C, 0.2847^{0}C, 1.3923^{0}C, 1.5483^{0}C, 1.5482^{0}C, 0.3003^{0}C, 0.3588^{0}C, 1.9617^{0}C, 1.1466^{0}C, respectively forNanded for the periods of 39 years. From above figure 3 it is clear that February shows highest fall in monthly mean of minimum temperature (Tmin) and which is 0.9048ºCand monthNovember shows highest increase which was 1.9617ºCfor the period of 39 year.

The trends of mean minimum seasonal temperature (Tmin) temperature shows upward trends except forsummer season which shows downward trends of 0.2379^{0}C for the periods of 39 years. Winter, monsoon, post monsoon shows increase in mean seasonal minimum temperature (Tmin) of 0.1911^{0}C, 1.1973^{0}C, 1.1583^{0}C respectively for the periods of 39 years. Monsoon shows highest increase of about 1.1973^{0}C for 39 years.

Table.3Statistical summary of monthly mean Tmean and seasonal temperature during 1969-2007 for Nanded.

Month	Mean	St. dev.	c. o. v	c. o. d	Y	Trend	Total Increase.
Jan	22.1786	1.0873	4.900	0.0028	0.0051x + 22.077	Upward	0.1989
Feb	24.2445	1.4633	6.040	0.0542	-0.0226x + 24.845	downward	-0.8814
Mar	28.0161	1.3900	4.960	0.0806	-0.0275x + 28.684	downward	-1.0725
Apr	31.8283	1.1037	3.470	4.00E-05	-0.0006x + 31.841	No trends	-0.0234
May	33.1315	1.2873	3.890	0.0534	-0.0261x + 33.654	downward	-1.0179
Jun	30.4088	1.6975	5.580	0.0028	0.0079x + 30.251	Upward	0.3081
Jul	27.4124	0.9974	3.640	0.0164	0.0112x + 27.188	Upward	0.4368
Aug	26.9083	0.9182	3.410	0.0754	0.0221x + 26.466	Upward	0.8619
Sep	26.9574	0.7779	2.890	0.0003	0.0011x + 26.935	Upward	0.0429
Oct	26.1919	1.0539	4.020	0.0014	0.0035x + 26.123	Upward	0.1365
Nov	23.1281	1.5763	6.820	0.0952	0.0427x + 22.275	Upward	1.6653
Dec	21.0577	1.0893	5.170	0.0211	0.0139x + 20.78	Upward	0.5421
Winter	23.2077	1.0416	4.4882	0.0103	-0.0064x +23.427	downward	-0.2496
Summer	30.9897	1.0884	3.5122	0.0469	0.0183x + 31.405	Upward	0.7137
Monsoon	27.9205	0.8414	3.0136	0.0208	0.0106x + 27.71	Upward	0.4134
Po. Mons.	23.4821	1.0039	4.2752	0.0547	0.0207x + 23.063	Upward	0.8073

The coefficient of variation for Tmean is highest in the month of November and it is observed as 6.820 % whereas it is lowest in the month of July and it is observed 2.33% for Nanded. This means that mean temperature is most stable in July and least stable in November for Nanded. For season, the coefficient of variation for Tmean is highest in the winter and it is observed as 3.52% whereas it is lowest in the monsoon and it is observed 2.42% for Nanded. This means that mean temperature is most stable in Monsoon and least stable in winter for Nanded.

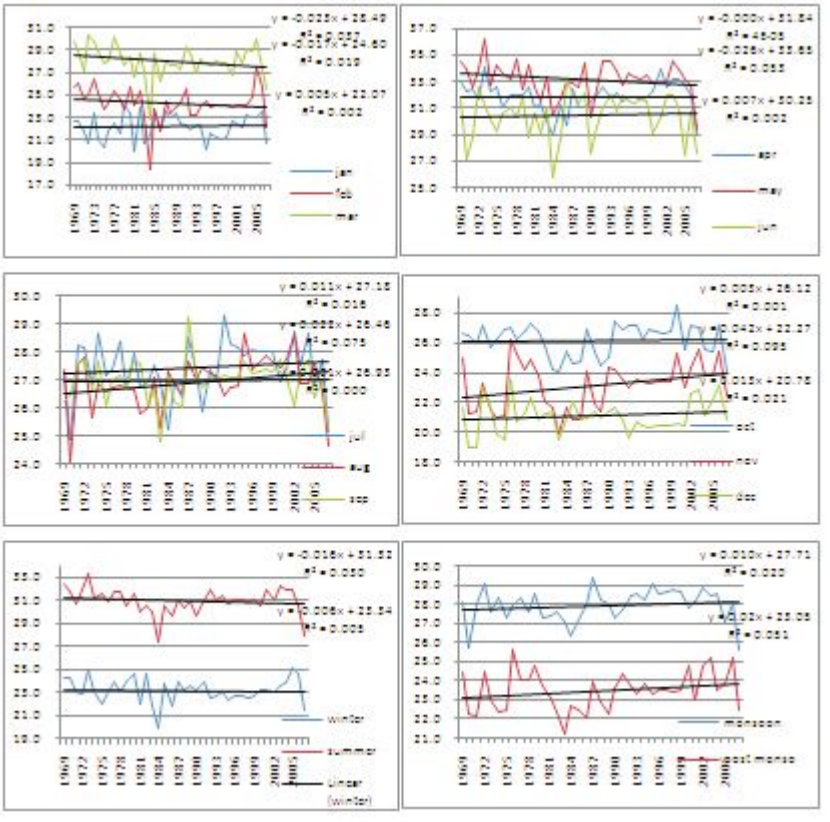


Figure 4 mean of mean monthly and seasonal temperature of Nanded

3. Trend Analysis of monthly and seasonal mean of Tmean of Nanded.

The trends of monthly mean of mean temperature (Tmean) were obtained using linear regression best fit lines. The linear regression equations and coefficient of determination for allthe months from January to December and for all the season from Winter to post monsoon are represented in table 3 and summarized from figure 3.It is evident from above figure 3 and table 3. That monthly mean of mean temperature (Tmean) of February, March and May shows downward trends and The total drop observed for thesewas 0.8814^{0}C, 1.0725^{0}C,1.0179^{0}Crespectively.January, June, July, August,September, October, November, December shows upward trends. The total increase for thesemonths was 0.1989^{0}C, 0.0.3081^{0}C, 0.4368^{0}C, 0.8619^{0}C, 0.0429^{0}C, 0.1365^{0}C, 1.6653^{0}C, 0.542^{0}C respectively forNanded for the periods of39 years. And April shows no trends.From above figure 3 it is clear that March shows highest fall in mean monthlymean temperature and which was 1.0725^{0}C.and monthNovember shows highest increase which is 1.6653ºC for the period of 39 year.

The trends of mean seasonal mean (Tmean) temperature shows downward trends forwinter and total fall was 0.2496 for the periods of 39 years. summer,monsoon, Post Monsoon shows upward trends for mean of seasonal meantemperature (Tmean) and total increase for that season was

0.7137^{0}C, 0.4134^{0}C, 0.8073^{0}C respectively for the periods of 39 years.Post monsoon season shows highest increasing trends of about 0.8073^{0}C for the total periods of 39 years.

5. CONCLUSION

It is identified that most of the linear trends of mean monthly maximum temperature (Tmax) shows upward trendsDecember shows highest increase in monthly mean Tmaxand it was 1.276^{0}C and for the period of 39 year., monthly mean of minimum temperature(Tmin), monthly mean of mean temperature (Tmean) were obtained using linear regression best fit lines For Nanded shows decreasing trends. For mean monthly maximum temperature March shows highest fall in mean monthly maximum temperature and which is 1.302^{0}C and month December shows highest increase which is 1.276^{0}C .Winter shows highest decrease in mean monthly maximum temperature and which 0.945^{0}C is. For monthly mean of minimum temperature(Tmin) February shows highest drop in Tmin and which is 1.856^{0}C and July Tmin shows highest growth which is 0.546^{0}C for the period of 39 year. Monsoon Tmin season shows increasing trends of 0.907^{0}C.Summer Tmin shows highest fall of about 0.945^{0}C.For monthly mean of mean temperature March shows highest fall in mean monthlymean temperature and which is 1.516^{0}C and month November shows highest increase which is 0.667^{0}C. Winter Tmean shows highest fall of about 1.146^{0}C and Post monsoonTmean shows increasing trends of about 0.336^{0}C.

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