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LONG YEARS COMPARATIVE CLIMATE CHANGE TREND ANALYSIS IN TERMS OF TEMPERATURE, COASTAL ANDHRA PRADESH, INDIA

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ABSTRACT

Climate Change is rapidly unfolding challenge of catastrophic at global, regional and national level. India is among the countries which will be hit hardest by the effects of climate change. The effect of these changes are exerting on all human struggle for survivable activity. Under the threat of global warming, it is vital to determine the impacts that future changes in climate may have on the environment and to what extent any adverse effects can be mitigated. In this research work the climate trends have been triggered recently and examined the difference between the trends of climate change for the period 1901 to 2007. Long term data was assessed for various aspects of East Coast of Andhra Pradesh climate using suitable statistical techniques of Mann Kendal trend test. Results indicate that variability for extreme temperature is increasing throughout the whole season. The change is significantly high for winter season than others. This is continuing further exacerbated by increased and more variable extreme temperatures. The clear demarcation in two groups of data (1901-1950 and 1951-2007 for temperature) is good indicator for understanding past and present situation. This means that when we compared the two types of data's interpretation of tests it, would lead us to draw much quit different conclusion for the same area. Therefore, it could be concluded that a significant changes of the temperature over the study area and has been increasingly affected by a significant change in climatic extremes during the second half of the 20th century. This might be the case of high level of emission of green house gases mainly carbondioxede. Global, regional, national, and local level mitigation options have to be implemented to minimize green house gases by using binding laws.

Keywords: Anthropogenic Sources, Climate Change, Mann Kendall Trend, Variability and Seasonality of Temperature

INTRODUCTION

Living and coping with uncertain impacts of climate change is no longer a choice; it is essential for our survival. Climate change poses a challenge to sustainability of social and economic development, livelihoods of communities and environmental management anywhere. Global atmospheric concentrations of greenhouse gases (GHGs) have increased markedly as a result of human activities since 1750 (Trenberth *et al*., 2007). Warming of the climate system is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea levels. An increase in the levels of GHGs could lead to greater warming, which, in turn, could have an impact on the world's climate, leading to the phenomenon known as climate change. Indeed, scientists have observed that over the 20th century, the mean global surface temperature increased by 0.6 ^{0}C (IPCC, 2001). In other report also, Climate change is predicted to impact upon the variability and seasonality of temperature and humidity, thereby involving the hydrologic cycle. Eleven of the last twelve years (1995-2006) rank among the 12 warmest years in the global instrumental record of surface temperature since 1850 (Trenberth *et al*., 2007).

Climate change and agriculture are inextricably linked. Agriculture still depends fundamentally on the weather. Climate change has already caused a negative impact on agriculture in many parts of the world because of increasingly severe weather patterns. Climate change is expected to continue to cause floods, worsen desertification and disrupt growing seasons. An increase in average global temperatures of just two to four degrees Celsius above pre-industrial levels could reduce crop yields by 15-35 % in Africa and western Asia, and by 25-35 % in the Middle East (FAO, 2001). An increase of two degrees alone could potentially cause the extinction of millions of species. Climate change creating additional threats to existing health problems in developing countries. Among the most likely health problems due to climate change are increased incidences of waterborne and vector-borne diseases due to more frequent flooding and higher temperature in such countries. According to Andhra Pradesh state reports on Climate Change, approximately 70% of shrimp consumed globally is farmed. India is ranked among the top five shrimp farming countries globally, and occurs mainly in the eastern coastal state of Andhra Pradesh (AP). More than 90% of the farms are less than 2 ha and are farmer owned, operated and managed. Accordingly, the study able to identify that the potential impacts difference between both (past & present) trends analysis then recommend ways for effectively tackling of climate change, increase our understanding about the reality of climatic change regionally and its influence, proof that “climate change is triggered recently or not”.

Here, standard statistical tests were employed to find evidence for such a trend in the available series of annual maximum and minimum temperature for the study area for a period of 1901 – 2007 at the 5% significance level and previous work of others have been reviewed. A possible adverse effect of world-wide climate change is an increase of extreme river discharges and associated flood risk (Milly *et al.* 2002, 2005; IPCC, 2007). The ability of certain trace gases to be relatively transparent to the incoming visible light from the sun yet opaque to the energy radiated from earth is one of the best understood processes in atmospheric sciences. The understanding of past and recent climate trend has been progressing significantly through improvements and extensions of numerous datasets and more sophisticated data analyses across the globe. Therefore, the study may able to realize whether climate change is real or not with the help of comparative trend analysis of data before 1950 and after 1950 and draw a conclusion of the two different scenarios of climate change by temperature variation.

METHODS

Study Area

Coastal Andhra is a region of India's Andhra Pradesh State which is located 78o- 89oE & 9o -22o N. According to the 2011 census, it has an area of 92,906 km2 and a population of 34,193,868. This area includes the coastal districts of Andhra Pradesh between the Eastern Ghats and the Bay of Bengal. It includes the districts of Srikakulam, Vizianagaram, Visakhapatnam, East Godavari, West Godavari, Krishna, Guntur, Prakasam and Nellore. Coastal Andhra has rich agricultural land, owing to the delta of the Godavari and Krishna rivers. The prosperity of Coastal Andhra can be attributed to its rich agricultural land and an abundant water supply from these two rivers. Rice grown in paddy fields is the main crop, with pulses and coconuts also being important. The fishing industry is also important to the region. Coastal Andhra is located to the east of Telangana and Rayalaseema regions share boarder with Odisha to the North and Tamil Nadu to the West. The State has the second longest coastline (972 km) among all the States in India.

Data Collection and Analysis

Time series data of temperature (minimum & maximum) collected from Indian Metrological department (IMD) from 1901 to 2007. According to IMD, the ground station unit has been divided according to homogeneity of temperature. So, data was collected from East Coast Metrological cluster of India which includes costal Andhra Pradesh. This study also used the data set of the regional monthly maximum and minimum temperature time series for the period, which was compiled by the Indian Institute of Tropical Meteorology (IITM). This dataset was obtained from http://www.tropmet.res.in.

Temperature data shows a long-term change in climatic pattern in the given temporal scale series. XLSTAT software was employed to analyze the trend analysis and to consider seasonal component. Hence, to describe a trend of a time series Mann-Kendall trend test was used. Mann-Kendall statistics (S) is one of non-parametric statistical test used for detecting trends of climatic variables. It is the most widely used method since it is less sensitive to outliers and it is the most robust as well as suitable for detecting trends (Gilbert, 1987). Hence, Mann- Kendall trend test was used to detect the trend and normalized Z-score for significant test. A score of +1 is awarded if the value in a time series is larger, or a score of -1 is awarded if it is smaller. The total score for the time-series data is the Mann-Kendall statistic, which is then compared to a critical value, to test whether the trend in temperature is increasing, decreasing or if no trend can be determined. The strength of the trend is proportional to the magnitude of the Mann-Kendall Statistic (i.e., large magnitudes indicate a strong trend). Data for performing the Mann-Kendall Analysis should be in time sequential order. The first step is to determine the sign of the difference between consecutive sample results. Sgn(Xj - Xk) is an indicator function that results in the values 1, 0, or –1 according to the sign of Xj - Xk where j > k, the function is calculated as follows.

- $\mathrm{sgn}(Xj - Xk) = 1 \text{ if } Xj - Xk > 0,$
- $\mathrm{sgn}(Xj - Xk) = 0 \text{ if } Xj - Xk = 0$
- $\mathrm{sgn}(Xj - Xk) = -1 \text{ if } Xj - Xk < 0$ ………………………..1

Where Xj and Xk are the sequential temperature values in months J and K(J>k) respectively whereas; A positive value is an indicator of increasing (upward) trend and a negative value is an indicator of decreasing (downward) trend. Let X1, X2, X3………….. Xn represents n data points (Monthly); Where Xj represents the data point at time J. Then the Mann-Kendall statistics (S) is defined as the sum of the number of positive differences minus the number of negative differences or given by:

$$S = \sum_{k=1}^{n-1} \sum_{j=k+n}^{n} \mathrm{sgn}(Xj - Xk)$$

Where $\mathrm{sgn}(Xj - Xk) = 1 \text{ if } Xj - Xk > 0,$

$\mathrm{sgn}(Xj - Xk) = 0 \text{ if } Xj - Xk = 0$

$\mathrm{sgn}(Xj - Xk) = -1 \text{ if } Xj - Xk < 0$ ……………………………..2

Trends considered at the study sites, were tested for significance. A normalized test statistics (Z-score) was used to check the statistical significance of the increasing or decreasing trend of mean temperature values. The trends of temperature were determined and their statistical significance were tested using Mann-Kendall trend significant test with the level of significance 0.05 (Z_α/2 = ±1.96).

$$Z = \frac{n-1}{\sqrt{\mathrm{var}(S)}} \quad \text{if } S > 0$$

$$Z = 0, \quad \text{if } S = 0$$

$$Z = \frac{n+1}{\sqrt{\mathrm{var}(S)}} \quad \text{if } S < 0$$

……………………..3

Accordingly, Ho=μ= μo (there no significant trend/stable trend in the data) HA= μ ≠ μo (there is significant trend/ unstable trend in the data). If –Z 1- α/2 ≤ Z ≤ Z1- α/2 accepts the hypothesis or else Reject Ho. Strongly Increasing or Decreasing trends indicate a higher level of statistical significance. So, in this way we can use Mann-Kendall trend test for temperature (T-Max & T-Min).

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RESULTS

In this section, the maximum and minimum temperature trend analyses are presented. The test interpretation and summary of the statistics of the months & seasonality have been tested and interpreted as follows.

Winter mean average of Minimum Temperature (Fig.1 & Table: 1-2): as the computed p-value is greater than the significance level alpha=0.05, one cannot reject the null hypothesis/Ho (there no significant trend/stable trend in the data). The risk to reject the Ho while it is true is 24.46%. Sen's slope: 0.006; Confidence interval:]-0.200, 0.183[. While, *Pre-monsoon* mean average of Minimum Temperature *(Table: 1-2)*: As the computed p-value is lower than the significance level alpha=0.05, one should reject the Ho, and accept the alternative hypothesis/Ha (there is significant trend/ unstable trend in the data). The risk to reject the Ho while it is true is lower than 1.32%. Sen's slope: 0.009; Confidence interval:]-0.119, 0.144[. Whereas, *Monsoon* mean average of Minimum Temperature *(Table: 1)*: as the computed p-value is lower than the significance level alpha=0.05, one should reject the Ho, and accept Ha. The risk to reject the Ho while it is true is lower than 0.07%. Continuity correction has been applied. Sen's slope: 0.005, Confidence interval:]-0.050, 0.056[. While, *Post-Monsoon* mean average of Minimum Temperature, *(Table: 1-2)*: as the computed p-value is greater than the significance level alpha=0.05, one cannot reject Ho. The risk to reject Ho while it is true is 10.99%. Continuity correction has been applied. Sen's slope: 0.008; Confidence interval:]-0.172, 0.166[. In general, the *Yearly* mean average of Minimum Temperature *(Fig.2 & Table: 1-2)*:, as the computed p-value is lower than the significance level alpha=0.05, one should reject Ho, and accept Ha. The risk to reject the null hypothesis while it is true is lower than 0.59%. Sen's slope: 0.007 Confidence interval:]-0.076, 0.085[.

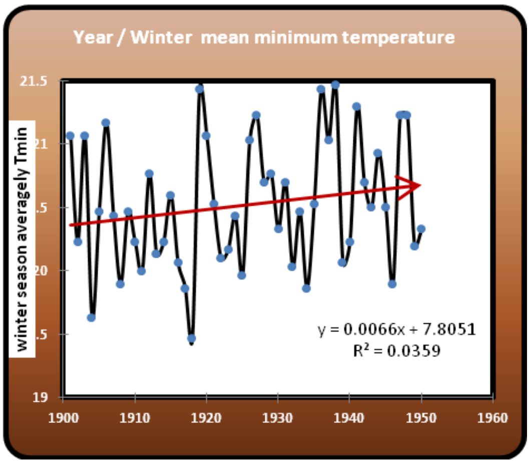

Figure 1. Winter averagely minimum Temperature

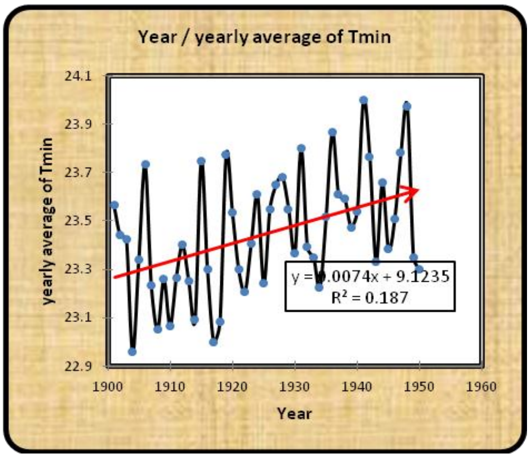

Figure 2. Yearly average for Minimum Temperature

Table 1. Statistical test summary table of Minimum Temperature

S. No.	Mann-Kendall trend test / Two-tailed test	Kendall's tau	S	Var(S)	p-value (Two-tailed)	alpha
	Minimum Temperature before 1950					
1	Winter season	0.115	140.000	14272.6	0.245	0.05
2	pre-monsoon season	0.245	297.000	14262.33	0.013	0.05
3	Monsoon season	0.341	405.000	14153.000	0.001	0.05
4	Post-Monsoon	0.158	192.000	14272.000	0.110	0.05
5	Yearly	0.270	330.000	14288.667	0.006	0.05
	Minimum Temperature after 1950					
1	Winter season averagely	0.248	393.000	21084.333	0.007	0.05
2	Pre-monsoon season	0.142	225.000	21071.667	0.123	0.05
3	Monsoon season	0.268	423.000	21056.333	0.004	0.05
4	Post-Monsoon	0.211	334.000	21076.667	0.022	0.05
5	Yearly	0.292	466.000	21098.667	0.001	0.05

Table 2: Summary statistics: Minimum temperature

Variable	Observations		Obs with missing data		Obs. without missing data		Minimum		Maximum		Mean		Std. deviation	
	Before 1950	After 1950	Before 1950	After 1950	Before 1950	After 1950	Before 1950	After 1950	Before 1950	After 1950	Before 1950	After 1950	Before 1950	After 1950
January	50	57	0	0	50	57	16.700	17.200	20.200	20.400	18.662	18.777	0.789	0.699
February	50	57	0	0	50	57	18.300	18.800	21.600	21.800	20.186	20.428	0.779	0.754
March	50	57	0	0	50	57	21.900	21.700	23.800	23.900	22.726	23.000	0.499	0.546
April	50	57	0	0	50	57	24.500	24.500	26.500	26.200	25.400	25.540	0.431	0.433
May	50	57	0	0	50	57	25.300	26.000	27.800	27.900	26.858	26.867	0.517	0.449
June	50	57	0	0	50	57	25.600	25.600	27.800	28.000	26.720	26.672	0.473	0.465
July	50	57	0	0	50	57	25.300	24.900	26.300	26.800	25.788	25.777	0.236	0.365
August	50	57	0	0	50	57	25.100	24.700	26.300	26.200	25.584	25.567	0.231	0.302
September	50	57	0	0	50	57	24.800	24.800	25.700	25.800	25.304	25.281	0.192	0.261
October	50	57	0	0	50	57	23.400	23.300	24.900	25.100	24.012	24.084	0.345	0.354
November	50	57	0	0	50	57	19.700	19.600	23.000	23.200	21.348	21.558	0.757	0.788
December	50	57	0	0	50	57	17.300	16.700	20.200	21.700	18.816	19.191	0.704	0.802
winter season	50	57	0	0	50	57	19.467	19.333	21.467	22.033	20.525	20.735	0.508	0.547
pre-monsoon season	50	57	0	0	50	57	25.333	25.433	27.000	27.100	26.326	26.360	0.365	0.334
monsoon season	50	57	0	0	50	57	25.100	24.800	25.967	26.000	25.559	25.542	0.167	0.272
post-monsoon season	50	57	0	0	50	57	20.333	20.367	22.367	22.967	21.392	21.611	0.439	0.488
yearly	50	57	0	0	50	57	22.958	22.908	24.000	24.292	23.450	23.562	0.251	0.302

Winter mean average of Minimum Temperature *(Fig.3 & Table: 2)*: as the computed p-value is lower than the significance level alpha=0.05, one should reject Ho, and accept Ha. The risk to reject Ho while it is true is lower than 0.69%. Sen's slope: 0.011 Confidence interval:]-0.154, 0.180[. Whereas, Pre-monsoon mean average of Minimum Temperature *(Table: 1)*: as the computed p-value is greater than the significance level alpha=0.05, one cannot reject Ho. The risk to reject Ho while it is true is 12.28%. Sen's slope: 0.004; Confidence interval:]-0.101, 0.097[. Whereas, Monsoon mean average of Minimum Temperature *(Table: 2a & b)*: as the computed p-value is lower than the significance level alpha=0.05, one should reject Ho, and accept Ha. The risk to reject Ho while it is true is lower than 0.36%. Sen's slope: 0.007. Confidence interval:]-0.078, 0.073[. While, *Post-monsoon* mean average of Minimum Temperature *(Table: 2a & b)*: as the computed p-value is lower than the significance level alpha=0.05, one should reject Ho, and accept Ha. The risk to reject Ho while it is true is lower than 2.18%. Sen's slope: 0.008, Confidence interval:]-0.150, 0.160[. And also, *Yearly* average mean minimum Temperature *(Fig.4 & Table: 2)*: as the computed p-value is lower than the significance level alpha=0.05, one should reject Ho, and accept Ha. The risk to reject Ho while it is true is lower than 0.14%. Sen's slope: 0.008; Confidence interval:]-0.077, 0.089[.

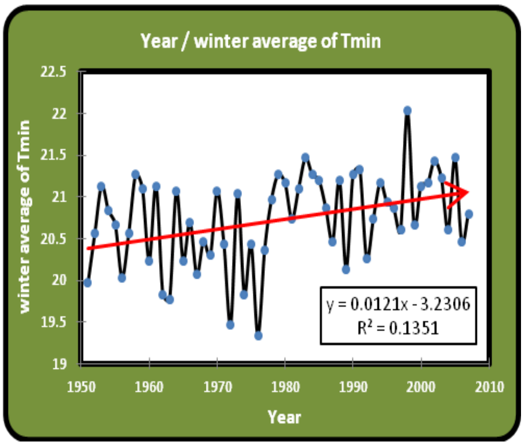

Figure 3. Winter Minimum Temperature

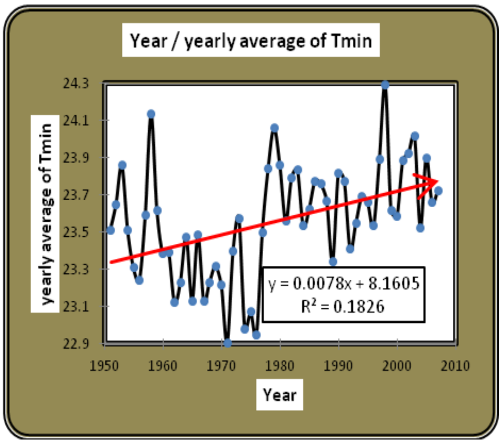

Figure 4. Yearly Minimum Temperature

Table 3: Statistical test summary table

S. No.	Maximum Temperature before 1950					
	Mann-Kendall trend test / Two-tailed test	Kendall's tau	S	Var (S)	*p-value (Two-tailed)	alpha
1	Winter season	-0.165	-200.000	14263.333	0.096	0.05
2	Pre-monsoon season	-0.154	-188.000	14280.000	0.118	0.05
3	Monsoon season	-0.200	-243.000	14271.667	0.043	0.05
4	Post-Monsoon	-0.067	-81.000	14265.667	0.503	0.05
5	Yearly	-0.292	-357.000	14287.667	0.003	0.05

Table 3: Statistical test summary table (Contd….)

Maximum Temperature after 1950						
S. No.	Mann-Kendall trend test / Two-tailed test	Kendall's tau	S	Var (S)	*p-value (Two-tailed)	alpha
1	Winter season	0.374	584.000	21002.000	< 0.0001	0.05
2	Pre-monsoon season	0.192	304.000	21078.000	0.037	0.05
3	Monsoon season	0.431	683.000	21074.33	< 0.0001	0.05
4	Post-Monsoon	0.405	643.000	21079.000	< 0.0001	0.05
5	Yearly	0.554	883.000	21097.000	< 0.0001	0.05

Winter mean average of maximum Temperature *(Fig.5 & Table: 3-4)*: as the computed p-value is greater than the significance level alpha=0.05, one cannot reject Ho. The risk to reject Ho while it is true is 9.57%. Sen's slope: -0.006. Confidence interval:]-0.126, 0.133[. Whereas, *Pre-monsoon* mean average of maximum Temperature (Table: 3-4*)*: As the computed p-value is greater than the significance level alpha=0.05, one cannot reject Ho. The risk to reject Ho while it is true is 11.76%. Sen's slope: -0.009. Confidence interval:]-0.215, 0.207[. Whereas, *Monsoon* mean average of maximum Temperature *(Table: 3-4)*: as the computed p-value is lower than the significance level alpha=0.05, one should reject Ho, and accept Ha. The risk to reject Ho while it is true is lower than 4.28%. Sen's slope: -0.008. Confidence interval:]-0.147, 0.121[. While, *Post-monsoon* mean average of maximum Temperature *(Table: 3-4)*: as the computed p-value is greater than the significance level alpha=0.05, one cannot reject Ho. The risk to reject Ho while it is true is 50.30%. Sen's slope: -0.002. Confidence interval:]-0.133, 0.133[. And also, *Yearly* mean average of maximum Temperature *(fig.6 & Table: 3-4)*: as the computed p-value is lower than the significance level alpha=0.05, one should reject Ho, and accept Ha. The risk to reject Ho while it is true is lower than 0.29%. Sen's slope: -0.007. Confidence interval:]-0.079, 0.066[.

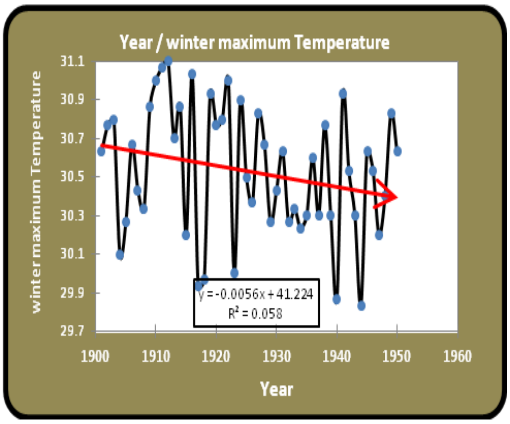

Figure 5. Winter Maximum Temperature

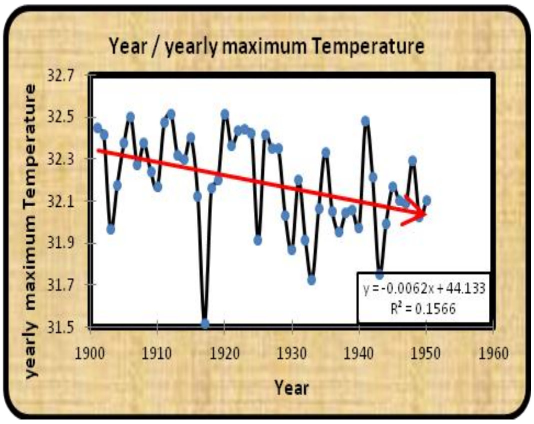

Figure 6. yearly average for Maximum Temperature

Table 4. Summary statistics: Maximum Temperature

Variable	Observations		Obs with missing data		Obs. without missing data		Minimum		Maximum		Mean		Std. deviation	
	Before 1950	After 1950	Before 1950	After 1950	Before 1950	After 1950	Before 1950	After 1950	Before 1950	After 1950	Before 1950	After 1950	Before 1950	After 1950
January	50	57	0	0	50	57	27.100	27.500	29.500	30.200	28.332	28.788	0.439	0.636
February	50	57	0	0	50	57	29.500	29.500	31.100	32.500	30.316	30.935	0.412	0.625
March	50	57	0	0	50	57	31.200	31.900	34.000	34.600	32.950	33.384	0.532	0.548
April	50	57	0	0	50	57	33.500	33.800	36.100	36.200	34.846	35.114	0.603	0.555
May	50	57	0	0	50	57	34.600	34.500	38.400	37.800	36.414	36.511	0.832	0.758
June	50	57	0	0	50	57	33.300	33.700	37.700	37.100	35.478	35.475	0.926	0.779
July	50	57	0	0	50	57	32.500	31.900	34.600	35.500	33.378	33.575	0.473	0.641
August	50	57	0	0	50	57	32.300	31.800	34.200	34.500	33.064	33.184	0.430	0.573
September	50	57	0	0	50	57	31.500	31.900	33.700	34.200	32.796	33.098	0.476	0.524
October	50	57	0	0	50	57	30.500	30.300	33.100	32.800	31.588	31.844	0.543	0.577
November	50	57	0	0	50	57	28.500	28.800	30.600	30.900	29.286	29.939	0.445	0.518
December	50	57	0	0	50	57	26.700	27.400	28.600	29.800	27.856	28.554	0.402	0.505
winter season	50	57	0	0	50	57	29.833	30.133	31.100	32.167	30.533	31.036	0.336	0.485
pre-monsoon season	50	57	0	0	50	57	34.467	34.467	36.600	36.667	35.579	35.700	0.543	0.445
monsoon season	50	57	0	0	50	57	32.400	32.167	33.900	34.367	33.079	33.286	0.366	0.469
post-monsoon season	50	57	0	0	50	57	28.900	29.100	30.633	30.933	29.577	30.112	0.346	0.431
yearly	50	57	0	0	50	57	31.517	31.642	32.517	33.150	32.192	32.533	0.228	0.339

Winter mean average of maximum temperature *(Fig.7 & Table: 3-4)*: as the computed p-value is lower than the significance level alpha=0.05, one should reject Ho, and accept Ha. The risk to reject Ho while it is true is lower than 0.01%. Sen's slope: 0.019 Confidence interval:]-0.114, 0.151[. While, *Pre-monsoon* mean average of maximum Temperature *(Table: 3-4)*: as the computed p-value is lower than the significance level alpha=0.05, one should reject Ho, and accept Ha. The risk to reject Ho while it is true is lower than 3.69%. Sen's slope:0.007 Confidence interval:]-0.121, 0.143[. Whereas, *Monsoon* mean average of maximum Temperature *(Table: 3-4)*: as the computed p-value is lower than the significance level alpha=0.05, one should reject Ho, and accept Ha. The risk to reject Ho while it is true is lower than 0.01%. Sen's slope: 0.016. Confidence interval:]-0.108, 0.142[. While, *Post-monsoon* mean average of maximum Temperature *(Table: 3-4)*: as the computed p-value is lower than the significance level alpha=0.05, one should reject Ho, and accept Ha. The risk to reject Ho while it is true is lower than 0.01%. Sen's slope:0.016 Confidence interval:]-0.100, 0.125[. And also, *Yearly* mean of maximum Temperature *(Fig.8 & Table: 4a & b)*: as the computed p-value is lower than the significance level alpha=0.05, one should reject Ho, and accept Ha. The risk to reject Ho while it is true is lower than 0.01%. Sen's slope: 0.014. Confidence interval:]-0.059, 0.088[.

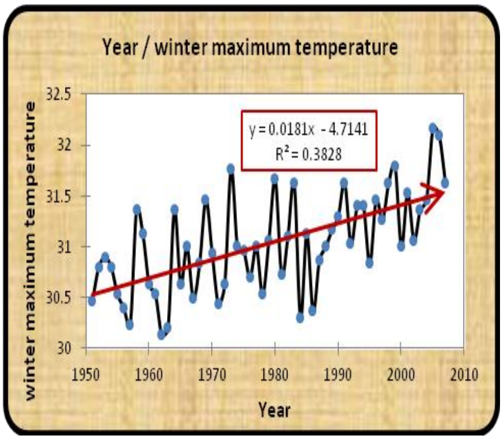

Figure 7. Winter averagely for Maximum Temperature

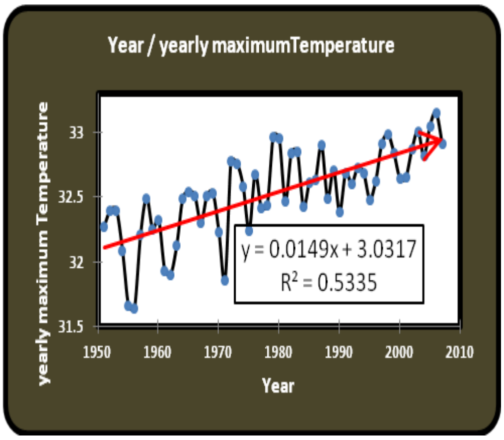

Figure 8. Yearly average for Maximum Temperature

Note: In all cases,

- Continuity correction has been applied.
- Ties have been detected in the data and the appropriate corrections have been applied.
- Average temperature trends also tested but not included here.
- The exact p-value could not be computed. An approximation has been used to compute the p-value.

CONCLUSION AND DISCUSSION

Here, in this study We have drawn conclusion on the basis of “Mann Kendall Trend Test Analysis” in order to say there is trend or not. Optionally or additionally, we can easily identify either trend is rising up or down or a stable trend. Statistical rule have used to evaluate the risks for rejection hypothesis. So, we can consider all state’s of trends. Based on slope value, negative or positive or zero, we can say there is change of increasing or decreasing or stable respectively.

Accordingly, earlier time (1901-1950) the range of temperature between upper limit & lower limit of maximum and minimum temperature was less than the recent values. Before 1950 the range of maximum temperature (upper and lower limit) was not more than ± 1.00 ^{0}C while the variance was 0.228. But the result of recent year (after 1950) was raised to ± 1.50 ^{0}C on yearly basis while the variance was 0.339^{0}C. This is one of the evidence for the hypothesis that Maximum temperature was triggered more recently as compared to earlier. Similarly, minimum temperature also earlier it was 1.015^{0}C and recently it reaches 1.384^{0}C. And variance was changed from 0.251^{0}C to 0.302^{0}C. In the period before 1950 the minimum temperature was rising with the slope factor of 0.0074X ^{0}C yearly but recently (after 1950) it becomes higher by the factors of 0.0078X ^{0}C yearly. However, Maximum temperature variability was quite different. Before 1950 the slope was negative in all tests (seasonally, yearly). Maximum temperature was decreasing with the factors of -0.0062X^{0}C (X=1901, 1902,……1950). While, reversed after 1950 which was raised to 0.0091X (X=1951, 1952, . .

. 2007). As a result of this finding, there was great change in all seasons. Recently, winter season temperature variability has been changed drastically as compared to others. So there is no uniformity in trend throughout all the seasons.

"Climate Change" is very slow on set processes. So that it exerts negative impacts on the awareness creation and slowly leading to great damage. But climate change is true. Averagely yearly temperature increasing by 0.0091X (T-Max) ^{0}C and 0.0078x (T-Min) ^{0}C. This is only from linear slope. But if we take the consideration of an extreme event in which there is extreme hot temperature or extreme cold temperature in which we exist today is very critical. Recently, these extreme events have been experienced with the potential of creating disasters in the area such as triggering cyclone in the case of variation of sea temperature. The temperature variability may have impacts on occurrence of disasters which resulted big losses in Andhra Pradesh as well as worldwide (Environment Protection, 2011).

The rate of climate change is varying from time to time for so on so forth reason. we can't say that the climate change in Costal Andhra Pradesh is due to developmental activities in the area only. Because, any anthropogenic activities in any part of the world may have impact on other parts of the world. But it matters. Therefore, it is difficult to take remedial activities unless there is global cooperation for action. when we see the trends in two different time periods increasing more and more in recent time than earlier. This may have an implication that climate changes have been triggered in recently. So, we can conclude that climate change is mainly triggered by anthropogenic sources especially due to the emission of human induced GHGs.

Effectively tackling climate change would in fact produce significant benefits, including fewer damages by avoiding problems. In the same way, reducing our consumption of fossil fuels (especially oil and gas) would help cut costs in importing these resources and substantially improve the security of energy supply. Similarly, reducing CO_2 emissions would help improve air quality, which will produce huge health benefits. The study has confirmed that the climate really is changing and there are signs that these changes have accelerated. The strategic options where they benefits outweigh the costs, such as improving energy efficiency, promoting renewable energy, adopting measures on air quality and recovery of methane from sources such as waste should be adopted. The state governments suppose to play important role in the enforcement of implementation, improvement of the energy efficiency and increasing, introducing renewable energy sources and developing an environmentally safe policy. In order to limit emissions in the transport sector, all the concerned government officials and NGO should work as hand and gloves. Cutting CO_2 emissions in other sectors, such as by improving the energy efficiency of residential and commercial buildings should be revised. It is recommended that reducing other gases, notably by adopting and strengthening measures on agriculture and forestry, setting limits for methane emissions from industry and gas engines and including these sources of emissions. It is also important to research on the environment, energy and transport and promoting the development of clean technology and increasing awareness in society. The action plans on energy technology and environmental technology must be fully implemented. Streamlining and expanding the clean development mechanism under the Kyoto Protocol to cover entire national sectors. So that building up the facilities to generate the cleanest energy is one among key solution. The battle against climate change can only be won through global action. So, International agreement must move towards concrete commitments. Developed countries must commit to cut their GHGs emissions according to international agreement and also have the technological and financial capacity to reduce their emissions.

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