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# To Measure Variability in Climatic Factors by Discriptive Statistics and Trend Analysis

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**ABSTRACT:** Climate change is today's burning issue, there are many questions arises on climate change. The present study gives the piece of information regarding the climate change at selected location of Hiriyur in Karnataka. The daily data sets of weather parameter were used to see the climate change in the present investigation. The daily secondary data for this study was obtained from ZARS Hiriyur for the period 1984 to 2013. The weather parameters - maximum temperature, minimum temperature, relative humidity, rainfall, evaporation, and sun shine hours were considered in study. Different statistical techniques applied to the data sets such as descriptive statistics and trend analysis. The variability noticed in the mean of three decades with respect to minimum temperature, evaporation and sun shine hours. There was more variation found in the minimum temperature and sun shine hours during 1$^{st}$ decade (1984-1993) also observed maximum variation in evaporation during 3$^{rd}$ decade (2004-2013) respectively. During the study period the rainfall, relative humidity, sun shine hours and evaporation indicating the declining trend, however the minimum temperature and maximum temperature indicating the increasing trend. Further the minimum temperature, sun shine hours and evaporation trend is found to be significant.

**KEYWORDS**: Weather parameters, Descriptive statistics and Trend analysis.

## I. INTRODUCTION

Climate has a vital role on biosphere of the earth. A very slight change in the climate will lead to a major change in plant and animal life. For example, some crops will not tolerate even a minute variation in temperature. Climate change could seriously threaten production levels required to feed the burgeoning population. Phenomenon of warming across the globe along with other falling consequences in the form of shift in rainfall pattern, melting of ice, rise in sea level etc. is getting accepted by the world community.

The long-range climate change has been observed worldwide and also the changes in food production and productivity of individual crop. This change is slow in nature and caused some area to lose their traditional crops and to go for alternative crops. Further it leads to shifting of cropping pattern and cropping season. The productivity of an individual crop has been changed resulting in variation in total production of the food grains.

The mean temperature in India is projected to increase by 0.1$^0$C to 0.3$^0$C in wet (Kharif) and 0.3$^0$C to 0.7$^0$C during dry (Rabi) seasons by 2010. Similarly mean rainfall is projected not to change significantly till 2010, but to increase by up to 10 per cent during 2070. At the same time, there is an increased possibility of climate extremes, such as the timing of onset of monsoon, intensities and frequencies of drought and floods etc. (Abha Mishra and Norman Uphoff , 2010)
While debate on the subject of global warming continues, most scientific studies indicate that climate is changing and becoming more unpredictable over time. Agriculture is more affected than other sectors of the economy by 'extreme' weather events and adverse trends: flooding, drought, cold spells, heat waves, cyclones, soil degradation. Unfortunately these are becoming more frequent and widespread. After boosting its agricultural status from deficit to surplus, India

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stands now to lose these gains. It is important to consider how our agricultural practices can be modified and adapted to make production of crops and animals more 'climate proof'.

Climate change is a long-term change in the statistical distribution of weather patterns over periods of time that range from decades to millions of years. It may be a change in the average weather conditions or a change in the distribution of weather events with respect to an average, for example, greater or fewer extreme weather events. Global average air temperature near the earth's surface raised 0.74 ± 0.18 °C (1.33 ± 0.32 °F) during the twentieth century. Climate change may be limited to a specific region, or may occur across the whole earth.
Global warming is an increase in the earth's temperature due to fossil fuels, industry, and agriculture processes caused by human, natural and other gas emissions. This is due to: an increased emission of greenhouse gases; short-wave solar radiation sinks into earth's atmosphere and warms its surface, and while long-wave infrared radiation emitted by earth's surface is absorbed, and then re-emitted by trace gases.

Increasing concentrations of greenhouse gases are likely to accelerate the rate of climate change. Scientists expect that the average global surface temperature could raise $1^0$F to $4.5^0$F ($06^0$C to $2.5^0$C) in the next fifty years, and $2.2^0$F -$10^0$F ($1.4^0$C -$5.8^0$C) in the next century with significant regional variation. As a result the evaporation will increase as the climate warms will increase average global precipitation. Soil moisture is likely to decline in many regions, and intense rainstorms are likely to become more frequent.

There are many questions arises on the climate change and agriculture practices, these are interrelated processes, both of which take place on a global scale. Global warming is projected to have significant impacts on conditions affecting agriculture, including temperature, carbon dioxide, glacial run-off, precipitation and the interaction of these elements. These conditions determine the carrying capacity of the biosphere to produce enough food for the human population and domesticated animals. The overall effect of climate change on agriculture will depend on the balance of these effects. Assessment of the effects of global climate changes on agriculture might help to properly anticipate and adapt farming to maximize agricultural production.
At the same time, agriculture has been shown to produce significant effects on climate change, primarily through the production and release of greenhouse gases such as carbon dioxide, methane, and nitrous oxide, but also by altering the earth's land cover, which can change its ability to absorb or reflect heat and light, thus contributing to radioactive forcing. Land use change such as deforestation and desertification, together with use of fossil fuels, are the major anthropogenic sources of carbon dioxide; agriculture itself is the major contributor to increasing methane and nitrous oxide concentrations in earth's atmosphere.

In the long run, the climatic change could affect agriculture in several ways: *Productivity*, in terms of quantity and quality of crops: *Agricultural practices*, through changes of water use (irrigation) and agricultural inputs such as herbicides, insecticides and fertilizers; *Environmental effects*, in particular in relation of frequency and intensity of soil drainage (leading to nitrogen leaching), soil erosion, reduction of crop diversity; *Rural space*, through the loss and gain of cultivated lands, land speculation, land renunciation, and hydraulic amenities, and *Adaptation*, organisms may become more or less competitive, as well as humans may develop urgency to develop more competitive organisms, such as flood resistant or salt resistant varieties.
The Karnataka state enjoys three main types of climates. For agro meteorological purposes, the state has been divided into 10 agro climatic zones namely,(1) *North Eastern Transition Zone, (2) North Eastern dry Zone, (3) Northern Dry zone, (4) Central Dry Zone,* (5) *Eastern dry zone,* (6) *Southern dry zone, (7) Southern Transition Zone , (8) Northern transition zone ,* (9) *Hilly zone and* (10) *Coastal Zone.*

Karnataka's State annual average rainfall is 1248 mm for the period 1991 to 2005. The state is divided into three meteorological zones viz. North Interior Karnataka, South Interior Karnataka and Coastal Karnataka. Coastal Karnataka with an average annual rainfall of 3456 mm is one of the rainiest regions in the country. Contrasting this, the region of South Interior Karnataka and North Interior Karnataka receive only 1286 and 731 mm of average annual rainfall. Out of 1248 mm of average annual rainfall of the State, about 886 mm (71%) received in the period of October-December (North-East monsoon) and only 149 mm (12%) during January to May. June receives highest

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monthly rainfall of 283 mm followed by 190 mm in August. The average annual rainfall in the districts of Karnataka varies from 562 mm in the Bagalkot district to 4119 mm in the Udupi district. Bagalkot, Chitradurga and Koppal are the districts which receive the least rainfall whereas Uttara Kannada, Dakshina Kannada, Chickmagalur and Udupi districts receive the heaviest rainfall.

In total, the crop growth period in rainfed areas extends from June to October. There is definite declining trend in rainfall in Kodagu, Chkkamagalur and South Canara districts. Few districts of the State have shown increasing trend in the annual rainfall. Bangalore, Kolar and Tumkur districts have shown increasing trend in the annual rainfall. Though the onset of monsoon remains during the 1$^{st}$ week of June, the adequate rainfall for crop growing period is shifted by about 15 to 20 days. Hence crop growing season itself shifted.

In recent years, July rains are decreasing and August rains are increasing and hence the sowing is extending up to mid-August. Due to this delayed sowing, flowering, peg initiation percentage reduces and total yield reduces. The groundnut crop suffered substantial damage because of high as well as low rainfall at different stages of crop growth. While heavy rainfall early in the season adversely affected the development of pegs, the relative dry spell at the later stage hit the development of pods. In addition to this, high rainfall and cloudiness during October encourages the spread of Tikka (leaf spot) that reduces the Green Leaf Area which further reduces the pod weight. Late sown groundnut will be more affected by Tikka. Due to climate change mid-season droughts are increasing due to dry weather, suffering of plants from lack of water, depletion of underground water supply.

## II. MATERIAL AND METHODS

Realising the above mentioned facts, the present study was conducted to analyse statistically measure the variability in climatic factors of Karnataka. The daily data sets of weather parameter for the period from 1984 to 2013 were collected from the Zonal Agricultural Research Station (ZARS) Hiriyur.

**Hiriyur** is a town and taluk capital located near Chitradurga in the state of Karnataka. It has a normally dry climate, with low rain fall. Hiriyur is located at 13°57′N 76°37′E. It has an average elevation of 630 meters (2066 feet). The months of March and April are the hottest months of the year.

The secondary data is obtained from the ZARS, Hiriyur and were used in the present study: namely weather data.

**Weather Parameters:**

X1: Maximum temperature ($^{o}$C)
X2: Minimum temperature ($^{o}$C)
X3: Relative humidity (%))
X4: Rainfall (mm)
X5: Evaporation (mm)
X6: Sunshine (hrs)

**Measurement of Variables**

**Weather parameters**

The weather parameters X1 to X6 were recorded at each station according to the standard method described below:

**X1: Maximum Temperature**

The Maximum temperature was recorded using max. degree Celsius in thermometer every day and averaged for each station.

**X2: Minimum Temperature**

Minimum temperature was recorded using min. degree Celsius in thermometer every day.

**X3: Relative humidity**

Relative humidity was measured by using sling psychrometer and recorded in percentage in the early morning every day.

**X4: Rainfall**

It was recorded by using standard rain gauge, every day in millimeter.

**X5: Evaporation**

Rate of evaporation was recorded by means of evaporimeter in millimeter every day.

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**X6: Sunshine hours**
It was measured by means of Campbell stokes sunshine recorder in hours every day.
To assess the climatic variability and its impact on crop production the following statistical tools were used.

**Descriptive statistics:-**
The descriptive statistics such as the Mean, Median, Mode, Standard Deviation (SD), coefficient of variability (CV), Skewness and Kurtosis were computed and used to study the variability of the weather parameters at selected location. The standard formulae were used to compute the various above said measures.

**3.3.2 Trend analysis:-**
Trend analysis is done by fitting the simple regression equation separately for each parameter over years for the period 1984-2013. Further, the trend line presented using graphs of Free hand curve fitting to know the trend of weather parameter over time.

## III. RESULTS AND DISCUSSION

In order to determine the variability in climatic factors both descriptive statistics and trend line was fitted.
The decadal statistics of weather parameters maximum temperature, minimum temperature, relative humidity, sunshine and evaporation were represented in table-2. The results of table – 2 showed that the variations in the climatic factors with respect to the decades. It was found that, the mean of three decades are statistically significant with respect minimum temperature, sun shine hours and evaporation and non-significant with respect to maximum temperature, relative humidity and rainfall. Further it was found that all the weather parameters are not symmetrically distributed over decades.

Trend analysis is carried out to observe any trend in the climatic factor at selected location for the period 1984-2013. The trends for each weather parameter have been calculated and linear trend equations were fitted to the data and results are presented in the table -1. It was found that the rainfall, relative humidity, sun shine hours and evaporation indicating the declining trend, however the minimum temperature and maximum temperature indicating the increasing trend. Further the minimum temperature, sun shine hours and evaporation trend is found to be significant.
Climatic factor such as maximum temperature, minimum temperature shows positive trend whereas rainfall, relative humidity, sun shine hours and evaporation indicate negative trend. The graphical represented of the trend of all-weather parameters presented in **fig 1**, **fig 2**, **fig 3**, **fig 4**, **fig 5**, **and fig 6**

The yearly rainfall status of Hiriyur was presented graphically in Fig 1. From the graph we can notice that there was definite increasing and decreasing pattern of rainfall observed over years. Thus we can notice from the above results discussed, there was a variation in climatic factors as the year advances. The fitted trend equation is given by

**Table - 1: Trend equations of weather parameters.**

| Weather Parameters | Fitted Trend Equation Hiriyur location |
|---|---|
| Maximum temperature ($^0$C) | $Y_t$ = 31.77 + 0.019t |
| Minimum temperature ($^0$C) | $Y_t$ = 16.5 + 0.110t* |
| Relative humidity (%) | $Y_t$ = 70.8 - 0.083t |
| Rainfall (mm) | $Y_t$ = 674.7 - 2.7219t |
| Sunshine (hrs) | $Y_t$ = 7.709 - 0.02t** |
| Evaporation(mm) | $Y_t$ = 6.421 - 0.089t** |
| * : Significant at 5 % level of significance  ** : Significant at 1% level of significance | |

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Table 2: Descriptive statistics of weather parameters of Hiriyur

| Parameters | Decade | Mean | Median | Mode | SD | CV | Min | Max | Skewness | Kurtosis | F-Value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Max. Temp. (°C) | 1984-1993 | 31.67 | 30.81 | 30.4 | 3.38 | 10.67 | 23.3 | 42.93 | 0.71 | 0.89 | |
| | 1994-2003 | 32.31 | 31.69 | 30.82 | 2.98 | 9.22 | 24.5 | 39.24 | 0.28 | -0.47 | |
| | 2004-2013 | 32.14 | 31.43 | 29.87 | 2.81 | 8.74 | 25.8 | 39.43 | 0.52 | -0.45 | $1.44^{NS}$ |
| Min. Temp. (°C) | 1984-1993 | 17.22 | 16.89 | 13.13 | 3.65 | 21.20 | 10 | 24.98 | -0.11 | -1.04 | |
| | 1994-2003 | 17.69 | 17.41 | 17.39 | 3.12 | 17.64 | 11.4 | 24.96 | 0.12 | -0.79 | |
| | 2004-2013 | 19.75 | 20.21 | 22.97 | 3.03 | 15.34 | 11.3 | 25.78 | -0.7 | 0.72 | 20.29** |
| Relative Humidity (%) | 1984-1993 | 69.8 | 70.18 | 72.9 | 9.85 | 14.11 | 46.1 | 95.56 | -0.21 | -0.2 | |
| | 1994-2003 | 70.54 | 69.79 | 69.84 | 9.98 | 14.15 | 46.6 | 88.98 | -0.01 | -0.67 | |
| | 2004-2013 | 68.19 | 67.85 | 66.19 | 9.14 | 13.40 | 44 | 90.85 | 0.09 | 0.18 | $1.86^{NS}$ |
| Rainfall (mm) | 1984-1993 | 688.33 | 761.8 | NA | 95.54 | 13.88 | 499.7 | 810.0 | -1.14 | 0.74 | |
| | 1994-2003 | 578.30 | 566.40 | NA | 111.43 | 19.26 | 427.7 | 769.2 | 0.25 | -0.89 | |
| | 2004-2013 | 630.99 | 632.25 | NA | 102.32 | 16.22 | 489.4 | 777.2 | -0.02 | -1.69 | $2.72^{NS}$ |
| Sunshine (hrs.) | 1984-1993 | 7.55 | 7.96 | 9.22 | 1.98 | 26.23 | 3.33 | 10.59 | -0.06 | -1.03 | |
| | 1994-2003 | 7.58 | 8.06 | 7.04 | 1.73 | 22.82 | 3.03 | 10.34 | -0.51 | -0.71 | |
| | 2004-2013 | 7.07 | 7.44 | 8.15 | 1.76 | 24.89 | 2.85 | 10.07 | -0.36 | -0.88 | 2.90* |
| Evaporation (mm) | 1984-1993 | 5.83 | 5.49 | 5.31 | 1.38 | 23.67 | 3.07 | 8.7 | 0.34 | -0.77 | |
| | 1994-2003 | 5.32 | 5.36 | 4 | 1.19 | 22.37 | 1.52 | 8.32 | -0.26 | 0.81 | |
| | 2004-2013 | 3.96 | 4.07 | 2 | 1.54 | 38.89 | 0.91 | 8.03 | 0.14 | -0.59 | 20.16** |

NS : Non-significant at 5% level significance, * : Significant at 5 % level of significance ** : Significant at 1 % level of significance

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**Fig. 1: Trend component of rainfall of Hiriyur location.**

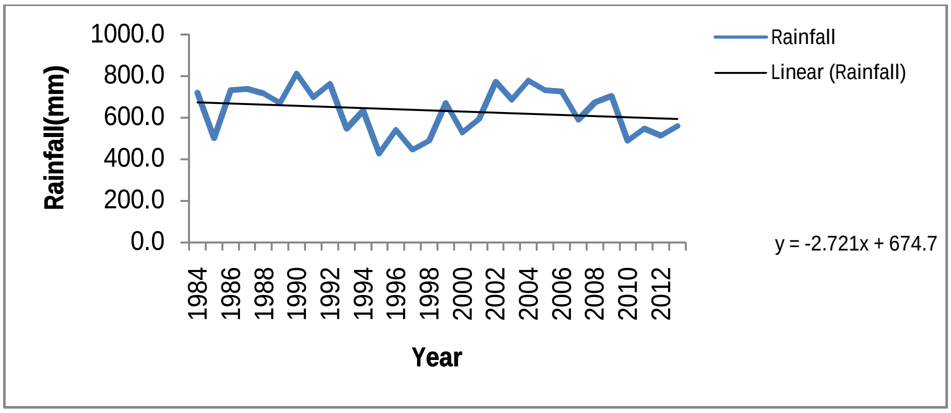


**Fig. 2: Trend component of relative humidity of Hiriyur location.**

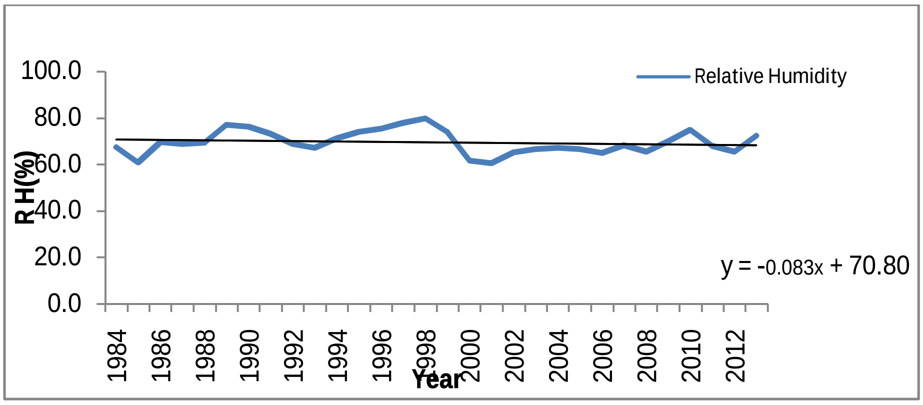


**Fig. 3: Trend component of Evaporation of Hiriyur location.**

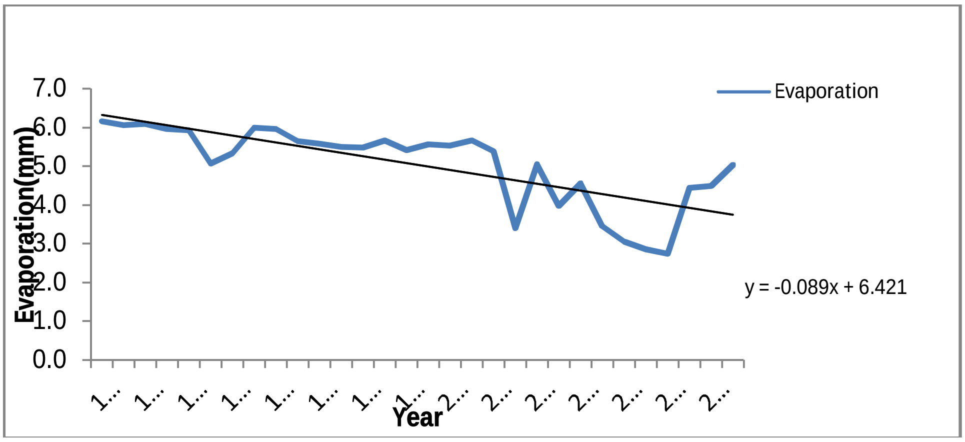

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**Fig. 4: Trend component of sun shine hours of Hiriyur location.**

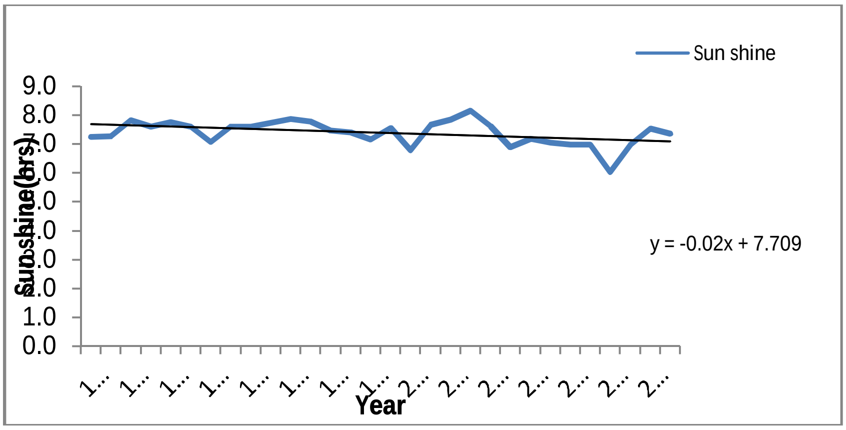



**Fig. 5: Trend component of maximum temperature of Hiriyur location.**

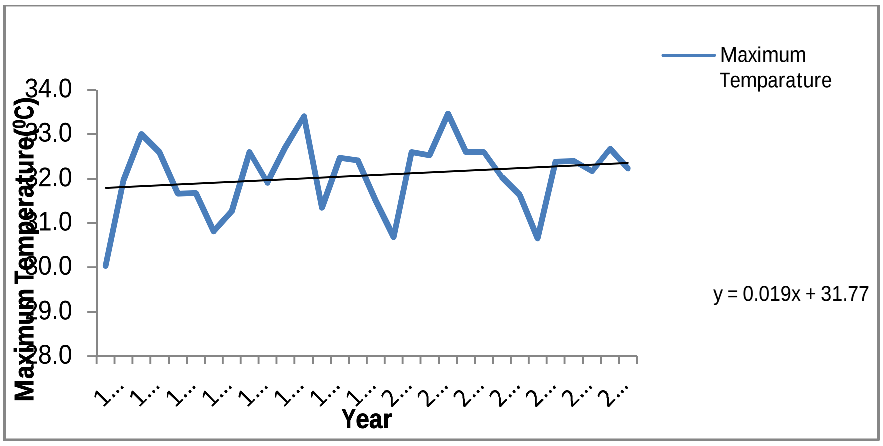
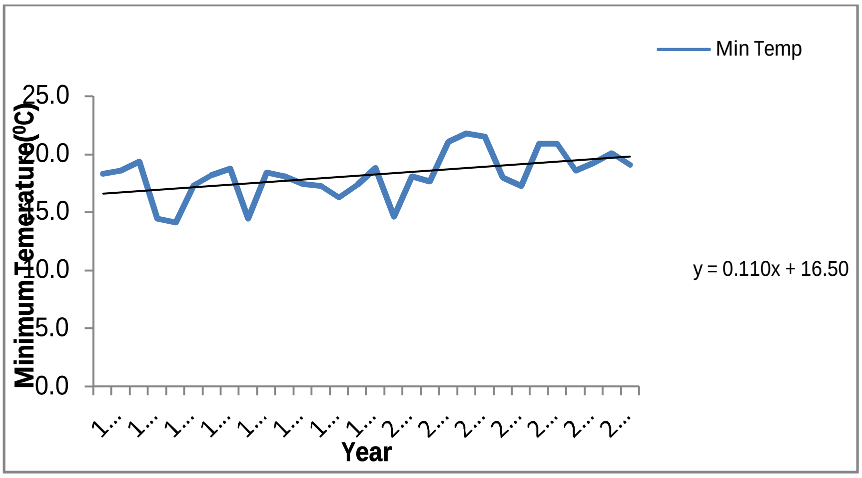



**Fig. 6: Trend component of minimum temperature of Hiriyur location.**



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