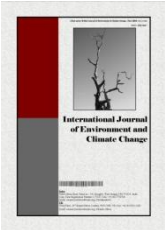

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Effect of ENSO on Seasonal Temperature Over Tamil Nadu

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Increased concentration of greenhouse gases is expected to alter the radiative balance of atmosphere, causing increase in temperature and changes in precipitation patterns. Climate variability has been principal source of fluctuations in Indian food production. Even though there is no long-term trend, inter - annual variability of Indian monsoon rainfall leading to frequent droughts and floods has profound influence on agriculture and intern, national economy. It is well recognized that El Niño / Southern Oscillation (ENSO) is the dominant mode of climate variability on seasonal to inter-annual scales and its impacts are felt worldwide. ENSO often affects seasonal temperature, precipitation and thus crop yields in many regions, however, the overall impacts of ENSO on global yields are uncertain Maximum and minimum average temperature was calculated for different seasons such as Cold Weather Period (CWP), Hot Weather Period (HWP), South West Monsoon (SWM), North East Monsoon (NEM) for each El Niño, La Niña and neutral years at various districts of Tamil Nadu. Relation between ENSO and temperature was analyzed by computing the anomaly in temperature at different districts of Tamil Nadu. The temperature deviation between the ENSO and neutral phases was not significant as the deviation was within $\pm$ 0.3^{o}C in all the seasons.

Keywords: ENSO; temperature; CWP; HWP; SWM; NEM.

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1. INTRODUCTION

"Increased concentration of greenhouse gases is expected to alter the radiative balance of atmosphere, causing increase in temperature and changes in precipitation patterns" [1]. "Climate variability has been principal source of fluctuations in Indian food production. Even though there is no long-term trend, inter - annual variability of Indian monsoon rainfall leading to frequent droughts and floods has profound influence on agriculture and intern, national economy" [2]. "Climate variability refers to departures from the mean position, that are usually called anomalies, over a given time period (for instance a month, a season, a year) from the long-term statistics. Many scientists have analyzed the climatic trends over India in the past. In the last 100 years the mean annual surface air temperature of India has increased by 0.4 - 0.6°C" [3]. Annamalai et al. [4] has reported "decreasing rainfall tendency in both Southwest and Northeast monsoon seasons in most parts of central and Northern India. In contrast, peninsular parts of India, particularly over the region 9-16^{o}N showed an increasing rainfall tendency and this increase was particularly strong during the Northeast monsoon season". Sivakumar et al. [5] has reported "warming trend of about 0.57^{0}C per 100 years over the Indian sub continent and increase in extreme rainfall events over Northwest India as well as decline in the number of rainy days along east coastal stations during the summer monsoon". "It is well recognized that El Niño / Southern Oscillation (ENSO) is the dominant mode of climate variability on seasonal to inter-annual scales and its impacts are felt worldwide" [6,7] ENSO often affects seasonal temperature, precipitation and thus crop yields in many regions, however, the overall impacts of ENSO on global yields are uncertain [8,9].

2. MATERIALS AND METHODS

2.1 Description of the Study Area

Tamil Nadu is located in the Southernmost tip of the Indian Peninsula between 8°5' and 13°35' North latitude and 76°15' and 80°20' East longitude.

2.2 ENSO Linked Climate Variability

El Niño is one of the important factors leading to climate variability. Operationally ENSO conditions are defined based on sea surface temperature variations and their persistence along the equatorial Pacific Ocean. The National Oceanic and Atmospheric Administration (NOAA) define El Niño and La Niña events based on a threshold of $\pm$ 0.5^{o}C for the Oceanic Niño Index (ONI) (3 months running mean of SST anomalies over equatorial eastern Pacific) (http://ggweather.com/enso/oni.htm). ENSO years segregated into two groups as El Niño and La Niña and remaining years were classified under neutral category.

2.3 Influence of ENSO on Temperature

Daily temperature data at district scale was obtained from India Meteorological Department (IMD) for a period of 43 years from 1971 – 2013 and segregated based on El Niño, La Niña and neutral years. Maximum and minimum average temperature was calculated for different seasons Cold Weather Period (CWP, January - February) Hot Weather Period (HWP, March - May) South West Monsoon season (SWM, June-September) and North East Monsoon (NEM, September-December) using Weather Cock Software. Relation between ENSO and temperature was analyzed by computing the anomaly in temperature at different districts of Tamil Nadu.

3. RESULTS AND DISCUSSION

3.1 Influence of ENSO on Temperature

Deviations of maximum and minimum temperatures from the normal maximum and minimum temperatures for Cold Weather period, (Figs. 1 and 2) maximum temperature in most of the districts deviated on the negative side by 0.11 to 0.3^{0}C in El Niño years. La Niña years

Table 1. El Niño, La Niña and neutral years from 1971 to 2013

El Niño	La Niña	Neutral
1972, 1976, 1977, 1979	1971, 1973, 1974, 1975	1978, 1980, 1981, 1985
1982, 1986, 1987, 1991	1983, 1984, 1988,1995	1989, 1990, 1992, 1993
1994,1997, 2002, 2004	1998, 1999, 2000,2007	1996, 2001, 2003, 2005
2006, 2009	2010, 2011	2008, 2012, 2013

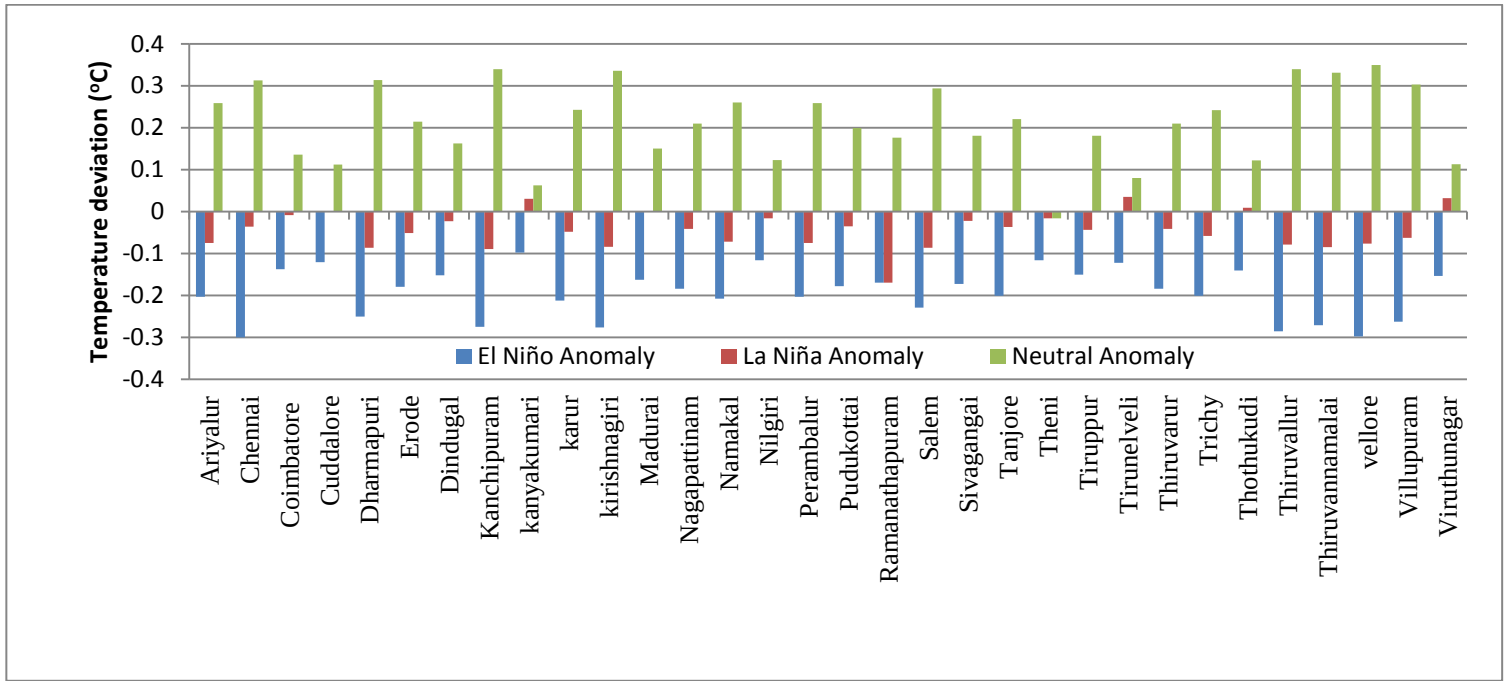

Fig. 1. Influence of ENSO on Cold Weather Period (CWP) mean maximum temperature over different districts in Tamil Nadu (1971 - 2013)

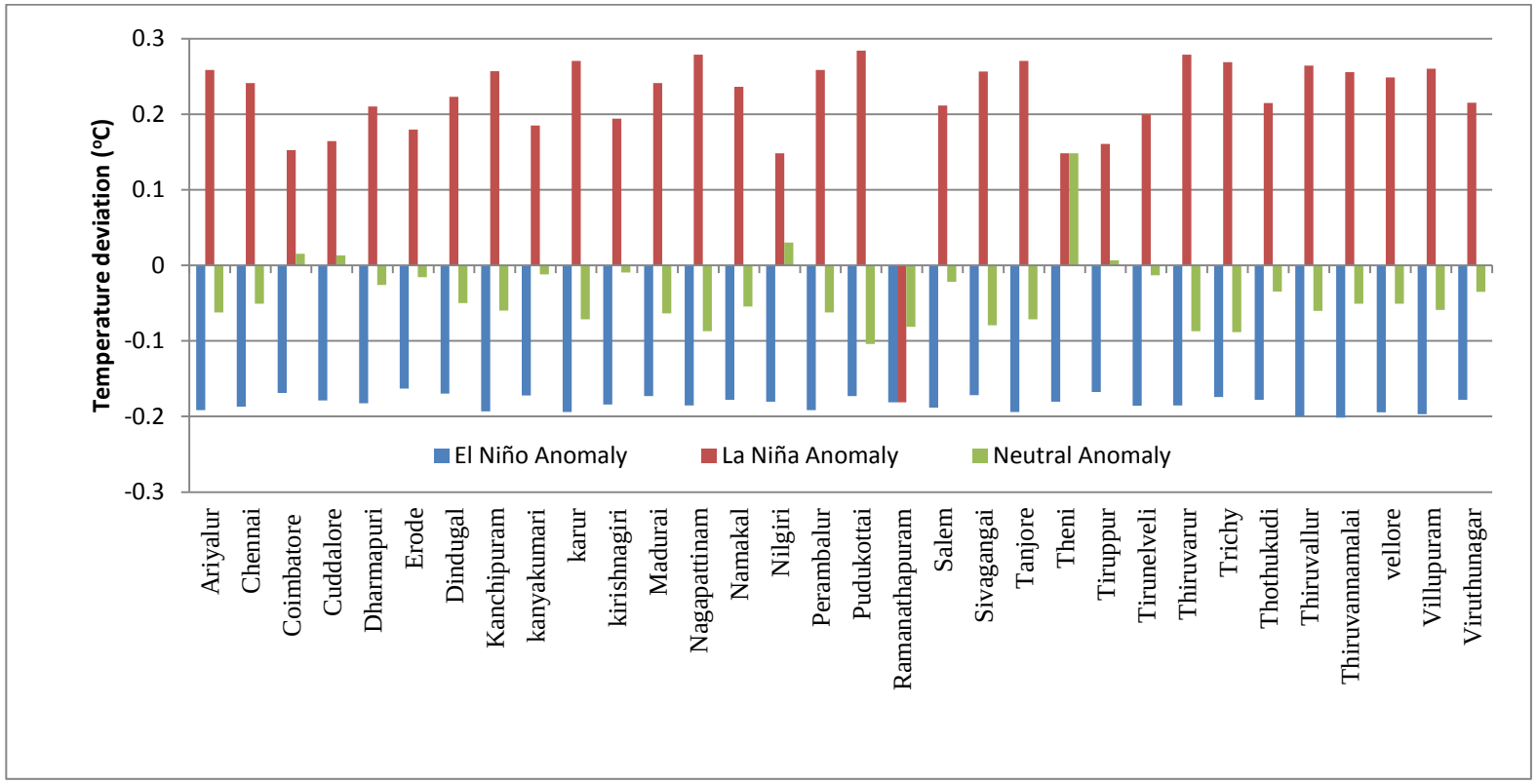

Fig. 2. Influence of ENSO on Cold Weather Period (CWP) mean minimum temperature in different districts in Tamil Nadu (1971 - 2013)

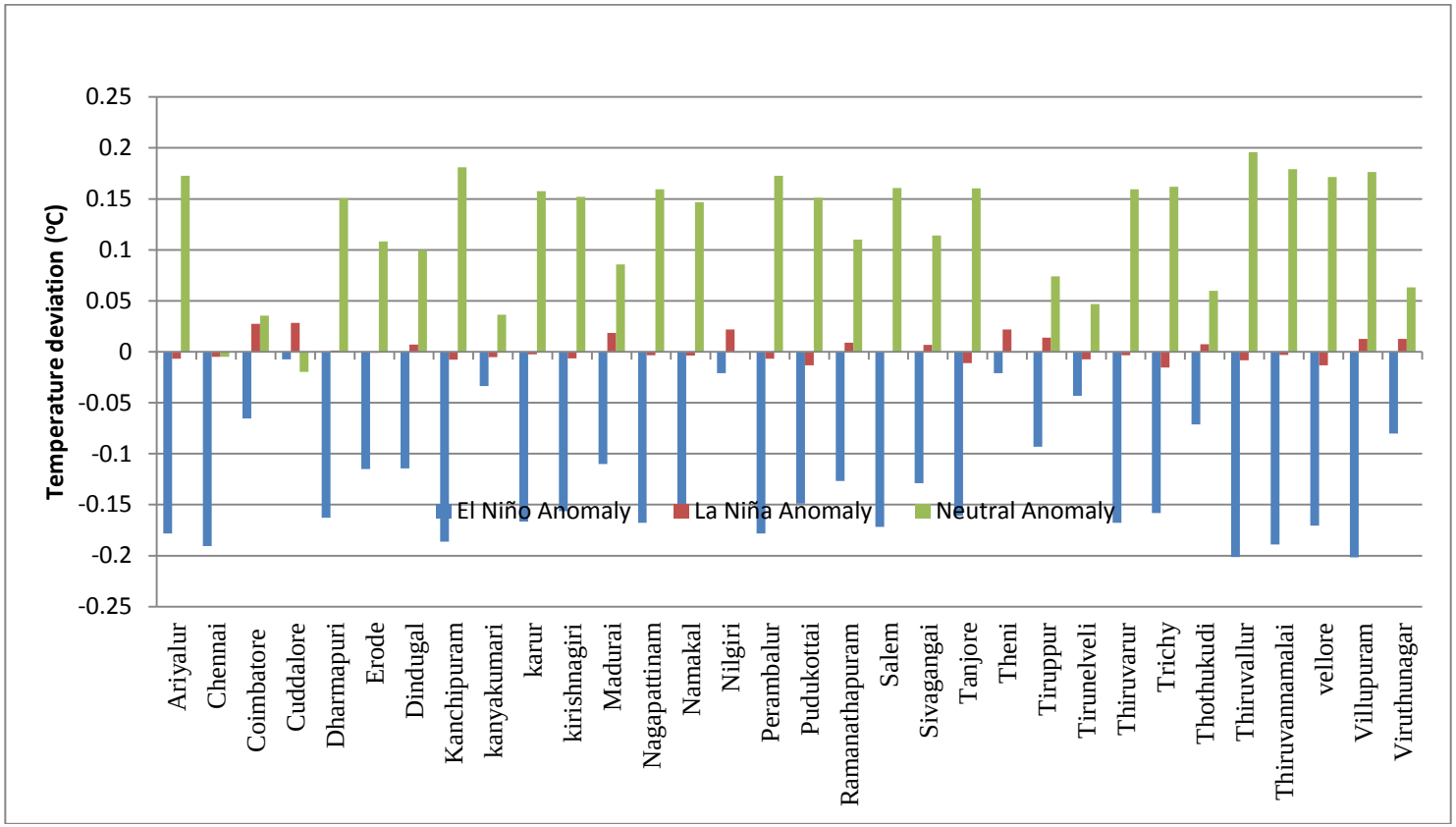

Fig. 3. Influence of ENSO on Hot Weather Period (HWP) mean maximum temperature over different districts in Tamil Nadu (1971 - 2013)

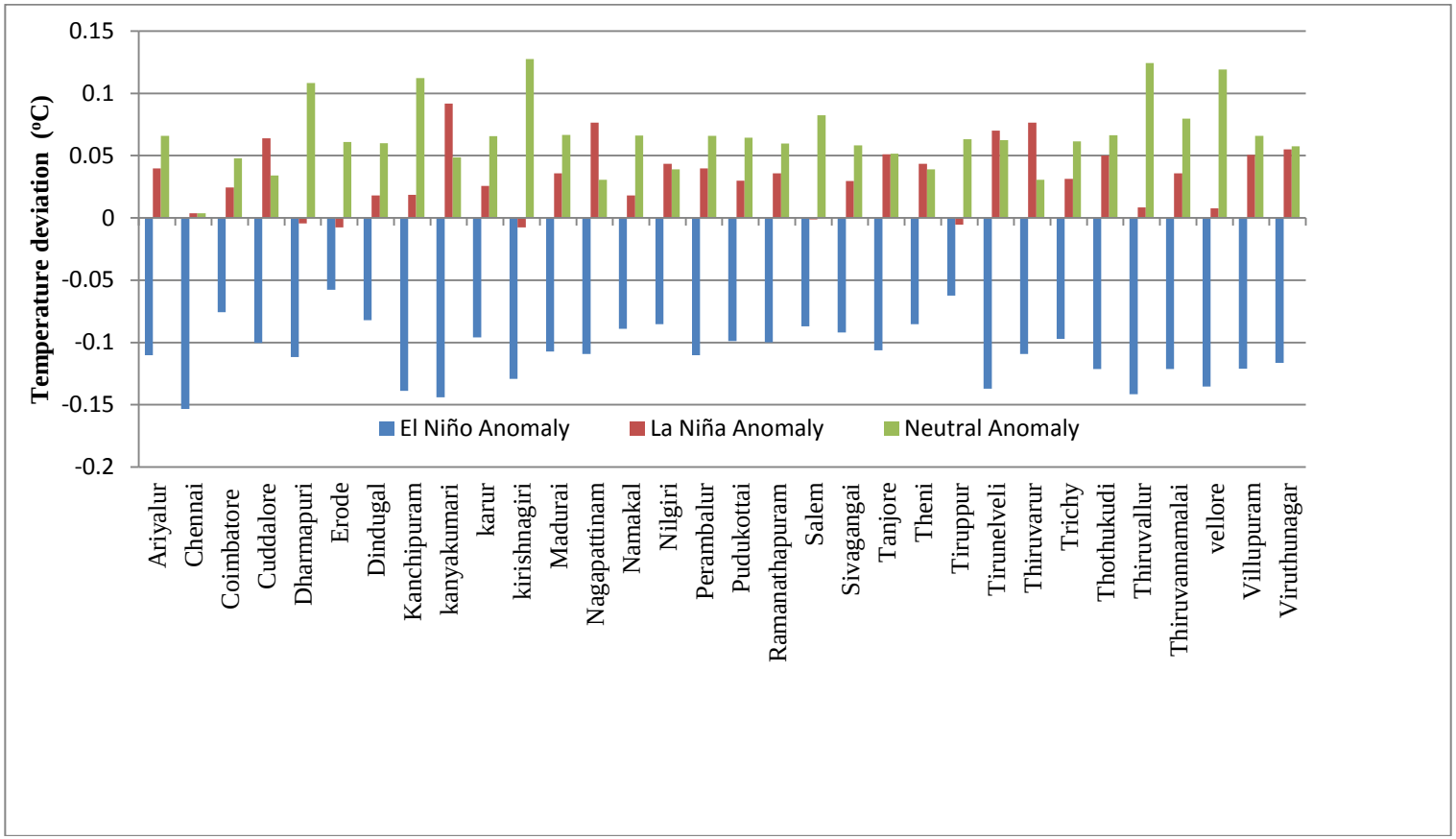

Fig. 4. Influence of ENSO on Hot Weather Period (HWP) mean minimum temperature over different districts in Tamil Nadu (1971 - 2013)

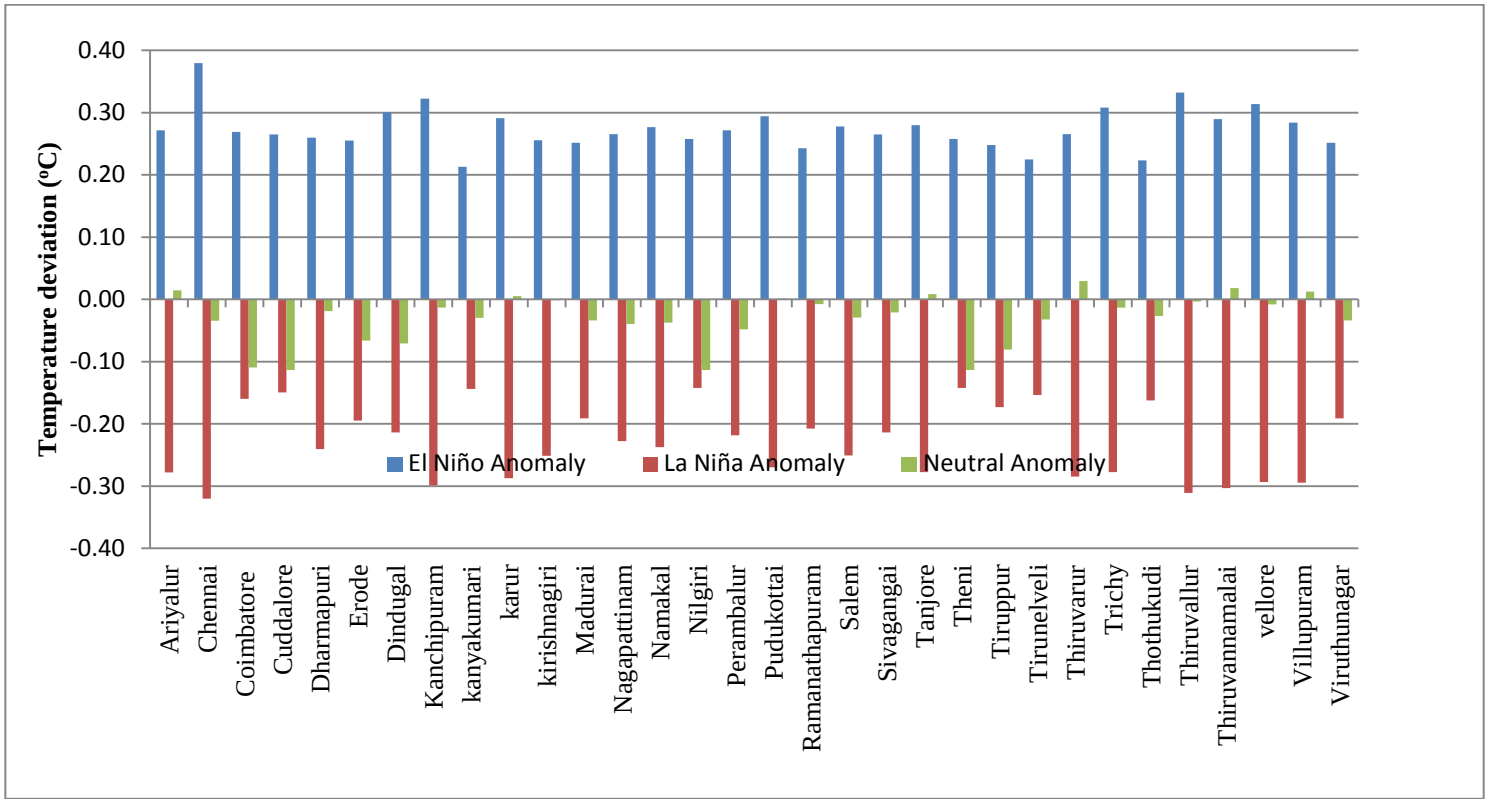

Fig. 5. Influence of ENSO on SWM mean maximum temperature over different districts in Tamil Nadu (1971 - 2013)

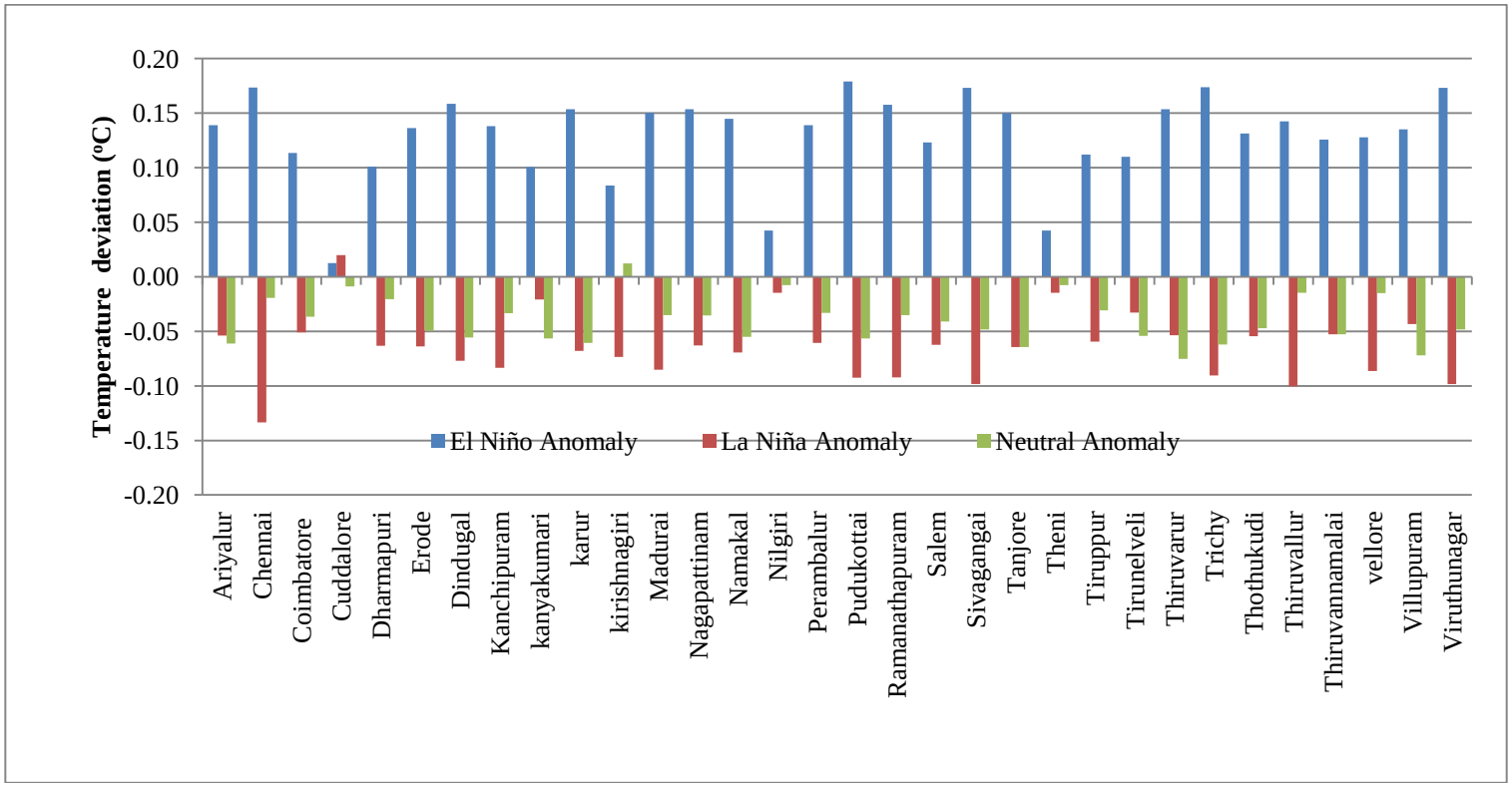

Fig. 6. Influence of ENSO on SWM mean minimum temperature over different districts in Tamil Nadu (1971 - 2013)

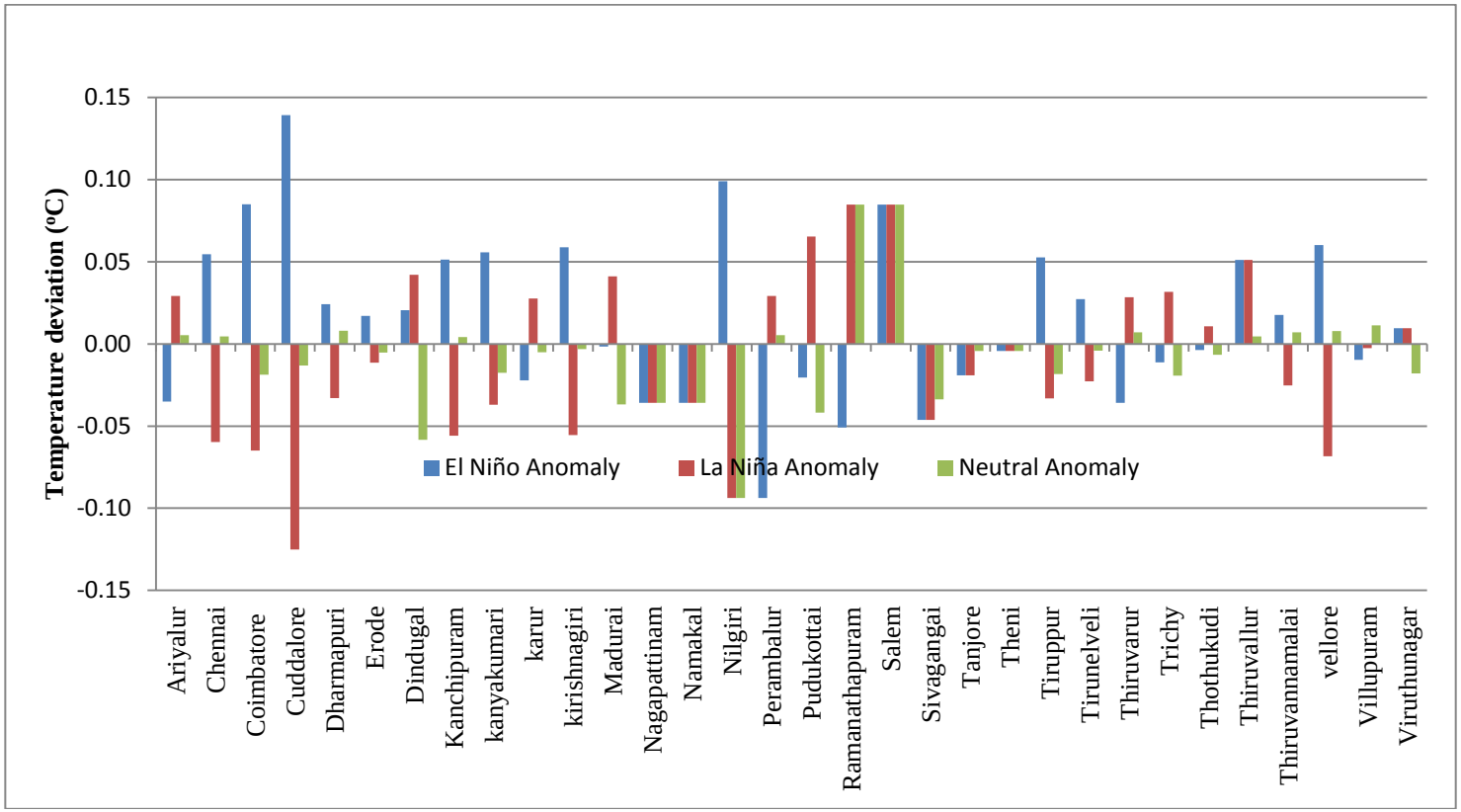

Fig. 7. Influence of ENSO on NEM mean maximum temperature over different districts in Tamil Nadu (1971 - 2013)

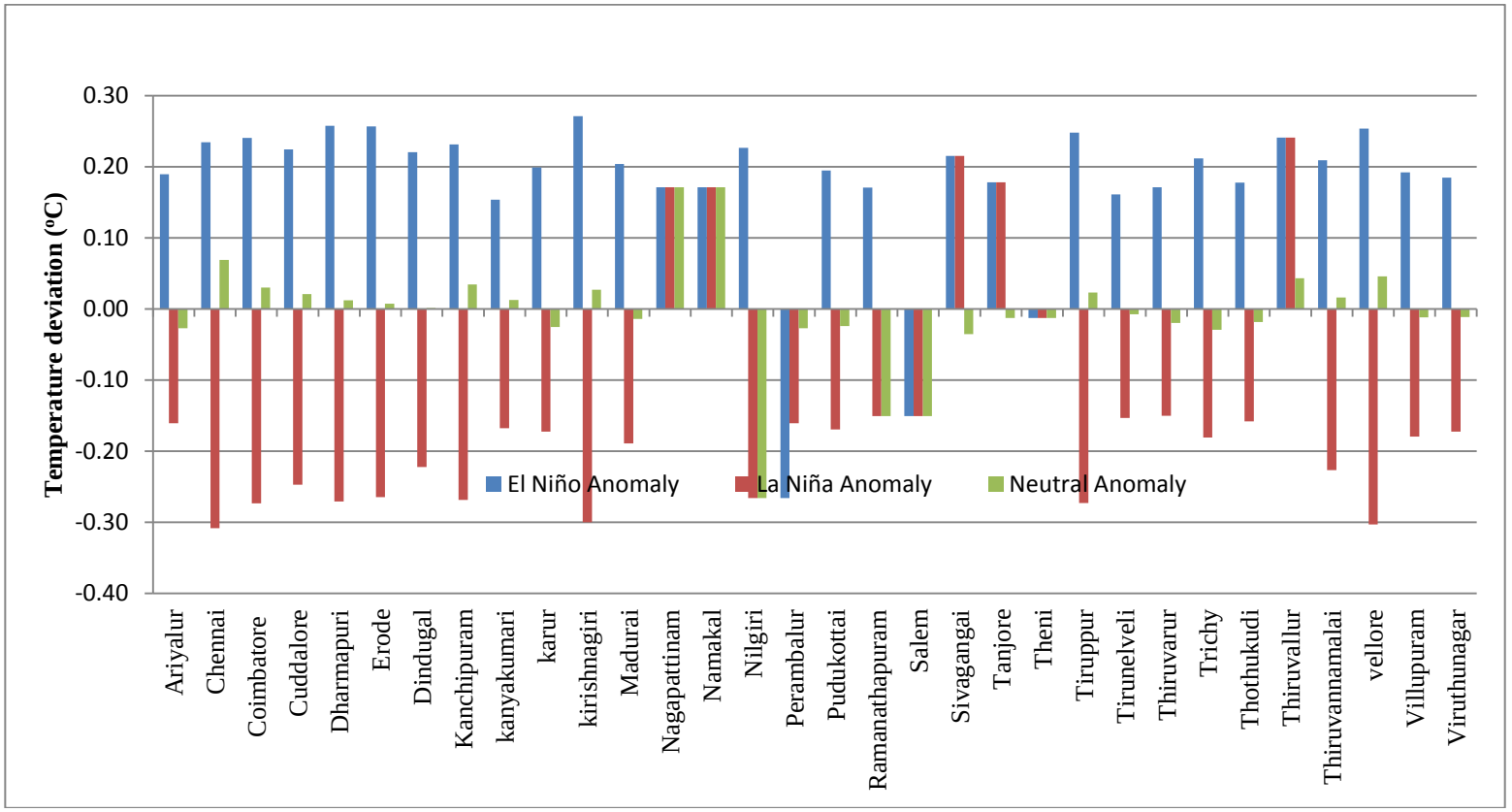

Fig. 8. Influence of ENSO on NEM mean minimum temperature over different districts in Tamil Nadu (1971 - 2013)

also recorded negative deviation in maximum temperature, but to a very small extent of mean deviation of -0.05^{0}C. In contrast to this neutral years exhibited positive deviation around 0.2^{0}C. Similar to maximum temperature, minimum temperature also deviated on the negative side deviation for the El Niño condition. However, La Niña years had positive deviation up to 0.29^{0}C. Neutral years had mean deviation of -0.05^{0}C.

Deviations of maximum and minimum temperatures from the normal maximum and minimum temperatures for Hot Weather period, (Figs. 3 and 4) during the El Niño situation exhibited negative deviation in both maximum and minimum temperatures up to 0.2^{0}C. In contrast, neutral condition exhibited positive deviation in both maximum and minimum temperatures to the tune of 0.2 and 0.15^{0}C, respectively. La Niña conditions exhibited no change for maximum temperature and a small positive change of less than 0.1^{0}C anomaly for minimum temperature.

In contrast to CWP and HWP, during SWM (Figs. 5 and 6) season positive deviation in both maximum and minimum temperature could be observed for the El Niño years. La Niña and neutral exhibited negative deviation and the magnitude was comparatively lesser under neutral years. A clear signal of increase or decrease in maximum temperature could not be observed for the NEM (Figs. 7 and 8) for El Niño and La Niña conditions. However, most of the districts exhibited positive deviation for minimum temperature during El Niño years and negative deviation for the La Niña years. Neutral years had no significant change for both the temperatures.

The temperature deviation between the ENSO and neutral phases was not significant as the deviation was within $\pm$ 0.3^{o}C in all the seasons (Cold Weather period; Hot Weather period; South West Monsoon and North East Monsoon). Many studies indicated that the ENSO effects on temperature are not significant. Ferreyra et al. [10] reported that no significant effect of ENSO on air temperature over central-eastern Argentina.

4. CONCLUSION

ENSO induced climate variability influenced the air temperature but statistically no significant effect of air temperature and ENSO for all season viz., Cold Weather period, Hot Weather period, South West Monsoon and North East Monsoon over Tamil Nadu. ENSO induced climate variability does not influenced the crop production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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