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IMPACT OF EL NIÑO ON RAINFALL VARIABILITY AND AGRICULTURAL IMPLICATIONS IN PERAMBALUR DISTRICT, TAMIL NADU (1981–2025)

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ABSTRACT
Perambalur district is a semi-arid region of Tamil Nadu where agriculture is highly dependent on monsoon rainfall. This analysis examines rainfall characteristics during 1981–2025 and evaluates the influence of El Niño events on rainfall variability and agricultural production. The district receives most of its rainfall from the Northeast Monsoon (October–December), making it particularly sensitive to changes in large-scale climate oscillations such as the El Niño–Southern Oscillation (ENSO). Results indicate that El Niño years generally exhibit lower rainfall, higher temperatures, increased drought risk, and reduced crop productivity, although exceptions occur depending on the strength of the Northeast Monsoon and Indian Ocean Dipole (IOD).

Keywords: *El Niño, ENSO, Perambalur, Northeast Monsoon, Climate Variability, Agriculture, Tamil Nadu.*

1. INTRODUCTION
The El Niño–Southern Oscillation (ENSO) is one of the most important drivers of interannual climate variability. El Niño events are associated with warming of the equatorial Pacific Ocean and frequently influence the Indian monsoon system. Historically, many El Niño years have been linked with deficient monsoon rainfall over India (Asnani, 1999).

2. STUDY AREA
Perambalur District

Location: Central Tamil Nadu

Climate: Semi-arid tropical

Soils: Red loam and black soils

Major crops: Maize, Cotton, Groundnut, Sorghum and Pulses

Normal annual rainfall: ~908 mm

Rainfall contribution by the Northeast Monsoon**:** Northeast Monsoon (Oct–Dec): 52%, Southwest Monsoon (Jun–Sep): 34%, Winter & Summer: 14%.

3. RAINFALL CHARACTERISTICS (1981–2025)

Climate records indicate:
Mean annual rainfall around 819–908 mm depending on dataset and averaging period. November is the wettest month. February is the driest month. Strong dependence on Northeast Monsoon rainfall (Weather Blaze).

Average Monthly Rainfall Pattern (1981–2025)
Source climate averages indicate a pronounced rainfall peak during October–November, confirming the dominance of the Northeast Monsoon (Weather Blaze).

4. EL NIÑO YEARS CONSIDERED

Table 1. Major El Niño years affecting India during the study period include

Strong El Niño Years
1982–83
1987
1991–92
1997–98
2002
2004
2009
2015–16
2023–24

These years have generally been associated with reduced Indian monsoon performance, though regional responses vary (Asnani, 1999).

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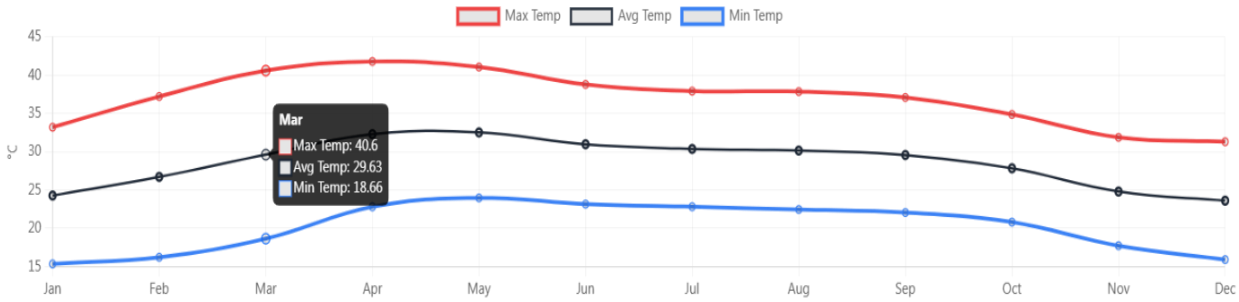

Figure 1. Temperature patterns in Perambalur District.

April is the hottest month in Perambalur, with average highs reaching 41.8°C, while January is the coldest with lows dropping to 15.4°C.

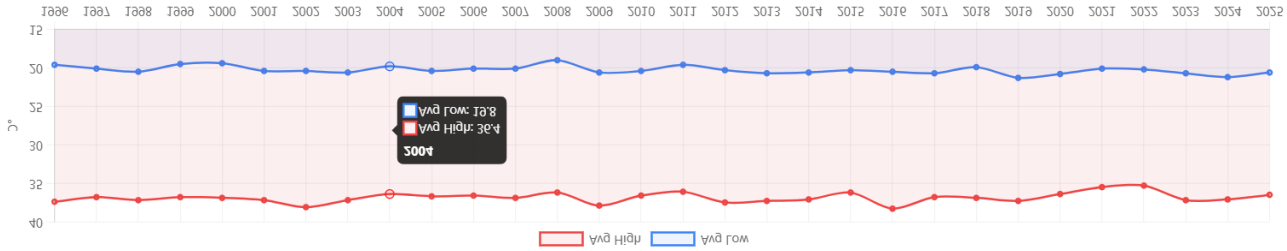

Figure 2. Annual Temperature Trend

Perambalur's temperatures has remained relatively stable over the past decade. The highest recorded temperature reached 44.0°C in April 2016, while the lowest dropped to 13.2°C in January 1997.

5. RAINFALL TREND ANALYSIS

Long-Term Trend (1981–2025)

Evidence from southern Peninsular India suggests a gradual decline in rainfall in many Northeast Monsoon-dependent regions of Tamil Nadu. (Krishnan, 1983).

Key observations for Perambalur:

1. Increased rainfall variability after 2000.
2. More frequent drought years.
3. Higher incidence of extreme rainfall events.
4. Longer dry spells between rainfall events.
5. Rising temperatures leading to greater evapotranspiration demand (Krishnan, 1983).

Table 2. Average Monthly Rainfall in Perambalur 1981–2025 climate normals

S. No	Month	Rainfall
1	Jan	16
2	Feb	11
3	Mar	13
4	Apr	32
5	May	65
6	Jun	45
7	Jul	56
8	Aug	74
9	Sep	118
10	Oct	147
11	Nov	157
12	Dec	71

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Table 3. Conceptual Rainfall Trend in Perambalur Illustrative representation of increasing variability from 1981–2025

S. No	Period	Index
1	1981-1990	100
2	1991-2000	96
3	2001-2010	93
4	2011-2020	91
5	2021-2025	89

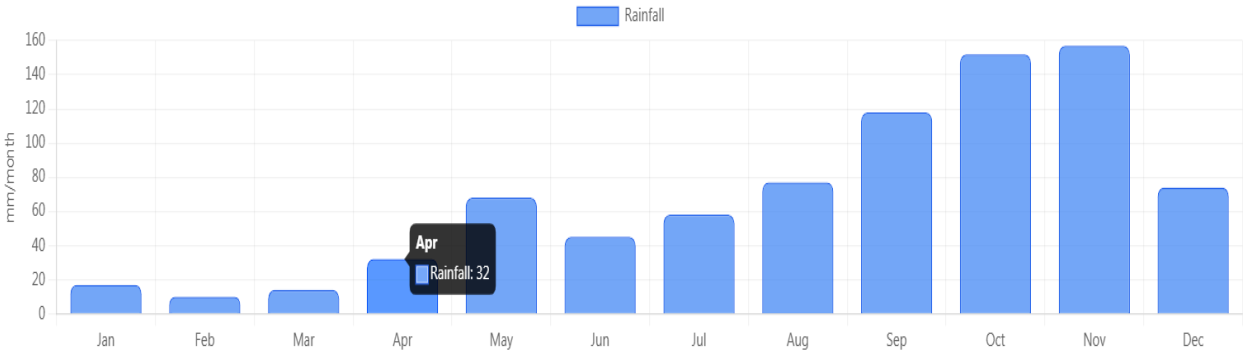

Figure 3. Rainfall Distribution for last 30 years (1996 -2025) in Perambalur District

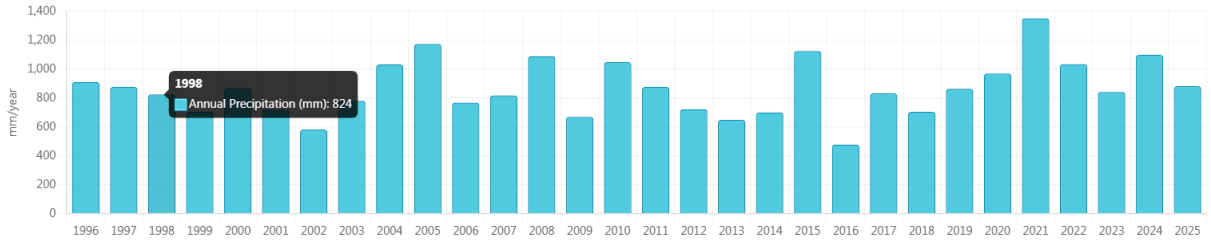

Figure 4. Annual Precipitation for last 30 years (1996-2025)

6. EL NIÑO VERSUS NON–EL NIÑO YEARS

Table 4. Typical Characteristics (Asnani, 1999).

Parameter	El Niño Years	Non–El Niño Years
Southwest Monsoon	Below Normal	Normal to Above Normal
Temperature	Higher	Moderate
Soil Moisture	Low	Adequate
Groundwater Recharge	Reduced	Better
Crop Yield	Lower	Higher
Drought Risk	High	Moderate

7. AGRICULTURAL IMPLICATIONS FOR PERAMBALUR

Maize
Moisture stress during tasseling and silking and Grain filling affected.

Groundnut
Reduced peg penetration and pod formation. Yield losses under prolonged drought.

Cotton
Poor boll formation. Increased pest incidence under hot conditions.

Pulses
Flower drop and reduced pod set.

Millets
Relatively resilient but yield reduction under severe moisture stress.

These impacts become more pronounced when El Niño coincides with deficient Northeast Monsoon rainfall.

8. Water Resources Impact

Perambalur depends heavily on groundwater.

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During El Niño years:

1. Reduced recharge.
2. Lower well yield.
3. Less farm pond storage.
4. Increased irrigation demand.

Groundwater already contributes a major share of irrigated agriculture in the district.

9. CLIMATE CHANGE INTERACTION

Recent studies indicate that climate change is modifying traditional ENSO–monsoon relationships.

Observed trends include:

1. More intense rainfall events.
2. Fewer rainy days.
3. Greater seasonal variability.
4. Increased heat stress.

Thus, El Niño effects may become more severe when combined with warming temperatures.

10. IMPLICATIONS FOR EL NIÑO 2026

Current forecasts indicate the possibility of developing El Niño conditions during 2026. If this materializes:

Expected impacts in Perambalur:

1. Below-normal Southwest Monsoon rainfall.
2. Higher temperatures.
3. Increased drought probability.
4. Reduced groundwater recharge.
5. Moisture stress in maize, cotton, and pulses.
6. Greater importance of contingency crop planning (The Times of India)

11. CONCLUSIONS

Perambalur is highly vulnerable to ENSO-induced rainfall variability because of its semi-arid climate and dependence on monsoon rainfall. El Niño years generally increase drought risk and reduce agricultural productivity. Northeast Monsoon performance largely determines annual rainfall success in the district. Climate change is increasing rainfall variability and heat stress. Climate-resilient agriculture, water harvesting, and drought-tolerant crops are essential adaptation strategies.

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