

The Impact of El Nino on Indian Weather & Agriculture: A Geographical Study

Dr. Pawar Suryakant Sukhdeorao

Dept. of Geography

Shivaji Mahavidyalaya, Renapur

Pawarsuryakant2@gmail.com

Abstract: *El Nino is a major global climatic phenomenon that significantly influences weather patterns across the world, including India. It is characterized by the unusual warming of sea surface temperatures in the central and eastern Pacific Ocean. Although it originates far from India, El Nino affects the southwest monsoon, which provides nearly 70% of the country's annual rainfall. Variations in the monsoon directly influence agriculture, water resources, food security, and the economy. Therefore, understanding the geographical impact of El Nino is essential for effective climate adaptation, disaster preparedness, and sustainable agricultural planning.*

Keywords: The Impact of El Nino on Indian Weather & Agriculture: A Geographical Study

I. INTRODUCTION

El Nino is a major global climatic phenomenon that significantly influences weather patterns across the world, including India. It is characterized by the unusual warming of sea surface temperatures in the central and eastern Pacific Ocean. Although it originates far from India, El Nino affects the southwest monsoon, which provides nearly 70% of the country's annual rainfall. Variations in the monsoon directly influence agriculture, water resources, food security, and the economy. Therefore, understanding the geographical impact of El Nino is essential for effective climate adaptation, disaster preparedness, and sustainable agricultural planning.

II. OBJECTIVES:

1. To understand the concept and characteristics of El Nino and examine its role in influencing global and Indian climatic conditions.
2. To analyse the impact of El Nino on the Indian southwest monsoon, with special reference to rainfall variability, drought occurrence, and water resource availability.
3. To examine the effects of El Nino on Indian agriculture, particularly on crop production, cropping patterns, irrigation demand, and farmers' livelihoods.
4. To study the geographical variations in the impact of El Nino across different regions of India and identify the area's most vulnerable to its effects.
5. To suggest suitable adaptation and mitigation measures for reducing the adverse impacts of El Nino on weather, agriculture, and sustainable development in India.

III. IMPACT ON MONSOON RAINFALL

1. Delay in Monsoon Onset

During El Nino years, the warming of the Pacific Ocean alters atmospheric circulation and weakens the monsoon system. As a result, the southwest monsoon often reaches the Indian mainland later than its normal arrival date. A delayed onset shortens the effective cropping season, particularly affecting rainfed agriculture. Farmers postpone sowing operations due to insufficient soil moisture, while water availability for domestic and agricultural purposes also declines. Such delays increase uncertainty in agricultural planning and reduce overall productivity.



2. Weak Monsoon Circulation

El Nino weakens the pressure difference between the Indian Ocean and the Asian landmass, reducing the strength of moisture-laden southwest monsoon winds. Consequently, fewer low-pressure systems and monsoon depressions develop over the Bay of Bengal. This weak circulation decreases cloud formation and rainfall over many parts of India. Central and north-western India are generally the most affected regions. Weak monsoon circulation not only reduces rainfall but also increases the likelihood of drought conditions and prolonged dry weather.

3. Below-Normal Seasonal Rainfall

One of the most common effects of El Nino is below-normal rainfall during the southwest monsoon season. Reduced rainfall lowers soil moisture, decreases river flow, and limits groundwater recharge. Agriculture, drinking water supply, and hydroelectric power generation are all adversely affected. Historical drought years such as 1972, 1987, 2002, 2009, and 2015 were associated with El Nino conditions. However, the intensity of rainfall reduction varies depending on the interaction of El Nino with other climatic systems such as the Indian Ocean Dipole.

4. Longer Dry Spells

El Nino often increases the frequency and duration of dry spells during the monsoon season. Even when total seasonal rainfall is close to normal, rainfall may occur in fewer events separated by long dry periods. These dry intervals reduce soil moisture during critical crop growth stages, affecting seed germination, flowering, and grain formation. Farmers become increasingly dependent on irrigation, while reservoirs and ponds receive insufficient recharge. Prolonged dry spells also increase the risk of agricultural drought and crop failure.

5. Uneven Spatial Distribution of Rainfall

The effects of El Nino are not uniform across India. While some regions receive significantly below-normal rainfall, others may experience near-normal or even above-normal rainfall due to local atmospheric conditions. This uneven spatial distribution creates regional disparities in agricultural production and water availability. States like Maharashtra, Rajasthan, Karnataka, and Madhya Pradesh often experience severe rainfall deficits, whereas parts of north-eastern or coastal India may receive comparatively better rainfall. Such variability complicates water resource planning and disaster management.

6. Increased Drought Frequency

Weak monsoon rainfall during El Nino years increases the likelihood of meteorological and agricultural droughts. Reduced rainfall leads to declining soil moisture, falling groundwater levels, and lower reservoir storage. Crop failures become more frequent, particularly in rainfed farming regions. Drought conditions also reduce drinking water availability, affect livestock, and increase rural unemployment. The government often has to provide drought relief, employment support, and food assistance. Repeated droughts may also encourage migration from rural to urban areas.

7. Reduction in Groundwater Recharge and Reservoir Storage

Groundwater and reservoirs are replenished mainly during the southwest monsoon. During El Nino years, deficient rainfall reduces infiltration into aquifers and lowers inflow into dams and reservoirs. As groundwater levels decline, irrigation becomes more expensive and less reliable. Reduced reservoir storage affects irrigation projects, drinking water supply, industrial activities, and hydroelectric power generation. The effects often continue long after the monsoon season ends, creating water scarcity during the dry months and increasing pressure on available water resources.



IV. IMPACT ON AGRICULTURE

1. Reduced Kharif Crop Production

Kharif crops depend heavily on monsoon rainfall. During El Nino years, deficient rainfall reduces soil moisture and affects crop establishment. Important crops such as rice, maize, soybean, cotton, and pulses experience poor growth because of inadequate water availability. Lower production directly affects food security and agricultural income. Rainfed farming regions of Maharashtra, Karnataka, Telangana, Madhya Pradesh, and Rajasthan are particularly vulnerable. Reduced kharif output also affects industries dependent on agricultural raw materials.

2. Decline in Crop Yields

El Nino lowers the productivity of major food and cash crops. Rice suffers due to water shortages during transplantation and grain filling. Maize and pulses experience reduced flowering and grain development, while cotton and soybean face moisture stress. Sugarcane productivity also declines where irrigation water becomes scarce. High temperatures associated with El Nino further reduce photosynthesis and increase crop stress. Consequently, agricultural production declines, affecting both farmers and consumers.

3. Delayed Sowing Due to Insufficient Rainfall

Farmers generally begin sowing after receiving adequate monsoon rainfall. When rainfall is delayed or insufficient, land preparation and sowing operations are postponed. Late sowing shortens the growing period and often exposes crops to unfavourable climatic conditions during flowering and harvesting. Many farmers shift to short-duration or drought-resistant crops, while others leave land fallow. Delayed sowing ultimately reduces crop yields and increases production risks, especially for small and marginal farmers.

4. Increased Irrigation Demand

Reduced rainfall forces farmers to rely more heavily on irrigation to maintain crop growth. This increases demand for canal water, tube wells, and borewells. The excessive use of groundwater accelerates depletion of aquifers and raises irrigation costs due to higher electricity and diesel consumption. In regions lacking irrigation infrastructure, crops often fail because supplementary water is unavailable. Sustainable irrigation practices such as drip irrigation and rainwater harvesting become increasingly important during El Nino years.

5. Reduced Fodder Availability and Livestock Productivity

Poor rainfall limits the growth of grasses, fodder crops, and crop residues, reducing the availability of animal feed. Fodder shortages force farmers to purchase expensive feed or reduce livestock numbers. Heat stress and inadequate nutrition lower milk production, weight gain, and reproductive efficiency in cattle and buffaloes. Poultry production may also decline during prolonged hot conditions. Since livestock is an important supplementary income source, reduced productivity significantly affects the rural economy.

6. Decline in Farmers' Income

Crop failures, reduced yields, and increased cultivation costs significantly lower farmers' income during El Nino years. Farmers spend more on irrigation, seeds, fertilizers, and pesticides while earning less from crop sales. Small and marginal farmers, who have limited financial resources, are particularly affected. Reduced agricultural income limits household expenditure on education, healthcare, and farm investments. Financial distress often increases indebtedness and may lead to seasonal migration in search of alternative employment opportunities.

7. Higher Food Prices

Lower agricultural production reduces the supply of cereals, pulses, vegetables, edible oils, and other food commodities. As demand remains relatively constant, market prices increase. Food inflation particularly affects poor and middle-



income households, reducing their purchasing power. Governments often intervene by releasing buffer stocks, encouraging imports, and implementing price stabilization measures. Persistent food inflation can also influence national economic growth, household nutrition, and social welfare, making El Nino an important concern for economic planning.

V. CONCLUSION

El Nino is a significant climatic phenomenon that strongly influences India's weather and agricultural systems. By weakening the southwest monsoon, it causes delayed rainfall, prolonged dry spells, droughts, and reduced water availability. These changes adversely affect crop production, livestock, farmers' income, and national food security. Although the intensity of its impact varies across different geographical regions, rainfed agricultural areas remain the most vulnerable. Improving seasonal weather forecasting, promoting climate-resilient agriculture, strengthening irrigation infrastructure, conserving water resources, and adopting sustainable farming practices are essential strategies for reducing the adverse effects of El Nino and ensuring long-term agricultural and environmental sustainability.

REFERENCES

1. Asnani, G. C. (2001). El Nino of 1997–1998 and Indian Monsoon. MAUSAM, India Meteorological Department.
2. Gadgil, S. (2003). The Indian Monsoon and Its Variability. Indian Academy of Sciences.
3. Goswami, B. N. (2006). South Asian Monsoon Dynamics. Indian Institute of Tropical Meteorology, Pune.
4. Krishnan, R., et al. (2020). Assessment of Climate Change over the Indian Region. Ministry of Earth Sciences, Government of India.
5. Rajeevan, M., Bhate, J., & Jaswal, A. K. (2007). Predictive Relationship between El Nino and Indian Summer Monsoon. India Meteorological Department.
6. Jenamani, R. K., & Dash, S. K. (2005). Role of Synoptic Weather Systems during El Nino Years. MAUSAM, IMD.

