Effect of EL Niño on Environment
A Study Of Environmental Impacts And Climate Variability

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Abstract
El Nino is one of the most significant climate phenomena affecting the global environment. It is characterized by the abnormal warming of sea surface temperatures in the central and eastern equatorial Pacific Ocean. Though it originates in the Pacific region, its consequences are global, altering weather patterns, marine ecosystems, agricultural productivity, and biodiversity. This research paper aims to analyze the environmental effects of El Nino based on secondary data collected from reputed organizations such as NOAA, NASA, and the India Meteorological Department (IMD). The study finds that El Nino intensifies global warming, disrupts monsoon systems, causes coral bleaching, increases forest fires, and leads to extreme weather events like droughts and floods. The paper concludes that while El Nino is a natural process, climate change is increasing its frequency and intensity, making effective mitigation and adaptation strategies essential.
***Keywords**: El Nino, ENSO, Climate Change, Global Warming, Monsoon, Marine ecosystem, Environment.*

1. Introduction:

The Earth's climate system is an interconnected system of ocean and atmosphere. One of the best examples of this connection is the El Nino Southern Oscillation (ENSO). ENSO is a recurring climate pattern involving changes in the temperature of waters in the central and eastern tropical Pacific Ocean.

ENSO has three phases:

a) El Nino - Warm phase
b) La Nina - Cold phase
c) Neutral phase

In normal conditions, trade winds blow strongly from east to west. These winds push warm surface water towards Indonesia and Australia, and cold, nutrient-rich water upwells along the coast of South America.

During El Niño, the trade winds weaken or even reverse. The warm water that is usually in the western Pacific moves eastward towards South America. As a result, the sea surface temperature in the eastern Pacific rises by 0.5°C to 3.0°C above normal. This small increase changes the atmospheric pressure, wind patterns, and rainfall distribution across the world.

El Niño events occur irregularly every 2 to 7 years and typically last 9 to 12 months. Some of the strongest El Niño events in recent history occurred in 1982-83, 1997-98, 2015-16, and 2023-24.

The term 'El Niño' was originally given by Peruvian fishermen who noticed the warming of ocean water around Christmas time. 'El Niño' in Spanish means 'The Little Boy' referring to Christ Child.

2. Objectives Of The Study:

1. To understand the scientific mechanism and causes of El Niño
2. To analyze the effects of El Niño on different components of the environment including atmosphere, hydrosphere, and biosphere
3. To study the specific impact of El Niño on India and the Indian Monsoon
4. To suggest suitable environmental management and adaptation strategies to reduce its adverse effects.

3. Research Methodology

The present study is descriptive and analytical in nature. It is based entirely on secondary data.

Sources of Data Collection:

1. Reports and data from NOAA Climate Prediction Center.
2. Data from NASA Earth Observatory.
3. Annual reports of the India Meteorological Department (IMD).
4. Research papers published in journals like Nature Climate Change and Bulletin of the American Meteorological Society.
5. IPCC Sixth Assessment Report.

4. Major Environmental Effects Of El Niño

4.1 Effect on Rainfall and Monsoon System

El Niño has a direct effect on the global Walker Circulation. The warming in the eastern Pacific shifts the region of heavy rainfall eastward.

- Drought in Western Pacific: Countries like India, Indonesia, Philippines, and Australia receive less than normal rainfall. About 60% of major droughts in India in the last century occurred during El Niño years. The monsoons of 2009, 2014, and 2015 were deficient by 20-25%.

- Floods in Eastern Pacific: The western coast of South America (Peru, Ecuador), southern USA, and parts of East Africa receive heavy rainfall, leading to floods and landslides.

4.2 Effect on Global Temperature

El Niño contributes significantly to temporary global warming. The extra heat stored in the Pacific Ocean is released into the atmosphere. The global mean temperature rises by 0.2°C to 0.4°C during a strong El Niño. This is why the hottest years on record - 2016 and 2023 - coincided with strong El Niño events.

4.3 Effect on Marine and Oceanic Environment

a) Suppression of Upwelling: Normally, cold water rich in nutrients comes up to the surface
near Peru. During El Niño, this upwelling stops.

b) Decline in Phytoplankton: Due to lack of nutrients, phytoplankton production decreases
by 30-50%.

c) Collapse of Fisheries: Fish species like anchovies either die or migrate. In 1972 and 1997,
the Peruvian anchovy fishery collapsed.

d) Coral Bleaching: Increased sea surface temperature causes thermal stress to corals. The
2016 global bleaching event destroyed about 30% of corals in the Great Barrier Reef.

e) Death of Seabirds and Sea Mammals: Due to lack of fish, seabirds and sea lions face starvation.

4.4 Effect on Agriculture and Forests

In India and Southeast Asia, drought reduces the yield of rice, wheat, and sugarcane. In Australia, wheat production drops significantly. In contrast, excessive rain in South America damages soybean and maize crops.

Drought and high temperatures during El Niño create ideal conditions for forest fires in Indonesia, Malaysia, Australia, and the Amazon. The 2015 Indonesian forest fires released more CO2 than the entire US economy in that period and created transboundary haze.

4.5 Effect on Biodiversity and Ecosystem

- Many bird species change their migration patterns.
- Animals in drought-prone areas face water shortage.
- Increased ocean acidity and temperature affect marine biodiversity.

4.6 Effect on Human Health and Air Quality

- Smoke from forest fires causes severe air pollution.
- Stagnant water after floods increases cases of malaria, dengue, and cholera.
- Drought leads to drinking water scarcity and malnutrition.
- Heatwaves during El Niño years increase heat-related deaths.

5. El Niño And India: A Detailed Analysis

India's monsoon provides about 70% of India's annual rainfall. When El Niño occurs, the temperature difference between the Indian landmass and the Indian Ocean decreases, weakening the monsoon winds.

- 2002, 2004, 2009, 2014, and 2015 were El Niño years with deficient monsoon (deficiency of 15-24%).
- The 2009 drought affected 30% of India's districts.
- Beyond monsoon, it weakens Western Disturbances, leading to less snowfall in Himalayas.
- Repeated droughts lower groundwater levels, which is a serious concern in Maharashtra, Rajasthan, and Karnataka.

6. Case Study: The 2015-16 El Niño Event

The 2015-16 El Niño was one of the three strongest ever recorded, called 'Godzilla El Niño'.

- It made 2016 the hottest year ever recorded at that time.
- In India: Monsoon was 14% deficient, leading to drought in Marathwada and Bundelkhand.
- In Indonesia: Over 2.6 million hectares of forest burned.
- In Africa: Ethiopia faced its worst drought in 50 years.
- In South America: River Paraguay flooded, displacing 100,000 people.

7. Mitigation And Adaptation Strategies

1. Early Warning Systems: Agencies like NOAA and IMD now predict El Niño 6-9 months in advance.
2. Water Conservation: Rainwater harvesting, watershed management, and drip irrigation.
3. Climate-Resilient Agriculture: Use of drought-resistant crop varieties and crop diversification.
4. Forest Management: Strict ban on slash-and-burn agriculture during El Niño years.
5. Marine Protection: Reducing overfishing and pollution.
6. International Cooperation: Sharing data and resources under Paris Climate Agreement.
7. Public Awareness: Educating farmers and fishermen about forecasts.

8. Conclusion

El Niño is a powerful reminder that our environment is a single, interconnected system. A temperature change of just 1-2°C in one part of the Pacific Ocean can cause drought in India, fire in Indonesia, and flood in Peru at the same time.

El Niño has mostly negative impacts - it disturbs rainfall, increases global temperature, damages marine life, reduces agricultural output, and causes air pollution. In the context of climate change, El Niño events are becoming more frequent and intense. For a country like India, understanding and preparing for El Niño is essential.

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