

Unit 1 - Agro-climatology

TOPIC 3: CLIMATE CHANGE INDICATORS

Introduction

Climate change refers to long-term shifts in temperature, precipitation patterns, and other atmospheric conditions, largely attributed to increased greenhouse gas concentrations from human activities since the industrial era. Identifying climate change indicators allows scientists and policymakers to track, quantify, and respond to these shifts, which is especially important for agriculture-dependent economies like India.

Major Climate Change Indicators

- 1. Rising Global and Regional Temperature** Increase in average surface temperature over decades, measured through long-term meteorological records; global mean temperature has risen significantly since pre-industrial times, with further warming projected.
- 2. Greenhouse Gas (GHG) Concentrations** Atmospheric concentrations of carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) are continuously monitored; their rising levels are a direct indicator and driver of climate change. Agriculture itself is both a source (methane from rice paddies and livestock, nitrous oxide from fertilizers) and a victim of climate change.
- 3. Changing Rainfall Patterns** Indicators include shifts in the timing of monsoon onset/withdrawal, increased frequency of extreme rainfall events alongside more frequent dry spells, and overall changes in seasonal rainfall distribution.
- 4. Sea Level Rise** Caused by thermal expansion of seawater and melting of glaciers/ice sheets; threatens coastal agricultural lands through saltwater intrusion and submergence.
- 5. Glacier Retreat and Snow Cover Change** Himalayan glaciers, which feed major Indian rivers used for irrigation, are retreating; reduced snow cover affects long-term water availability for agriculture.
- 6. Frequency and Intensity of Extreme Weather Events** Increased occurrence of heat waves, cold waves, droughts, floods, and cyclones is a key observable indicator of a changing climate system.
- 7. Phenological Shifts** Changes in the timing of natural biological events—such as earlier flowering of plants, shifts in migratory bird patterns, and altered crop growth stages—serve as biological indicators of climate change.

8. Ocean Acidification Increased absorption of atmospheric CO₂ by oceans lowers ocean pH, affecting marine ecosystems and, indirectly, fisheries-based livelihoods.

9. Shrinking Arctic Sea Ice A widely cited global indicator, though more relevant to global climate monitoring than direct Indian agriculture, it reflects overall planetary warming trends.

Methods of Monitoring Climate Change Indicators

- Long-term meteorological station data (temperature, rainfall records).
- Satellite remote sensing (ice cover, vegetation indices, sea surface temperature).
- Ice core and tree-ring analysis for historical climate reconstruction.
- Ocean buoys and weather balloons for atmospheric and oceanic data.

Relevance to Agriculture

Monitoring these indicators helps in: - Developing climate-resilient crop varieties. - Adjusting crop calendars to shifting seasons. - Formulating adaptation and mitigation strategies for sustainable farming.
