



Climate Change: Causes and consequences of climate change, mitigation and adaptation strategies, and global initiatives like the Paris Agreement and IPCC reports

I. Causes of Climate Change

1. Natural Causes (*Minor contributors today*):

- **Volcanic Eruptions:** Release CO₂, SO₂, and ash, temporarily cooling the Earth.
- **Solar Variability:** Changes in solar output can influence Earth's climate.
- **Ocean Currents:** Natural cycles like El Niño/La Niña affect global climate patterns.
- **Earth's Orbital Changes:** Milankovitch cycles affect solar radiation received by Earth.

2. Anthropogenic (Human-Induced) Causes (*Primary drivers today*):

- **Greenhouse Gas (GHG) Emissions:**
 - **Carbon dioxide (CO₂)** from fossil fuels (coal, oil, gas), deforestation.
 - **Methane (CH₄)** from livestock, landfills, rice paddies.
 - **Nitrous oxide (N₂O)** from fertilizers, industrial processes.
 - **Fluorinated gases** from industrial and refrigeration systems.
- **Deforestation:**
 - Reduces carbon sinks.
 - Increases CO₂ in atmosphere.
- **Industrialization & Urbanization:**
 - High energy use, construction, and waste production.
 - Urban Heat Island effect.
- **Agricultural Activities:**
 - Emit CH₄ (livestock) and N₂O (fertilizers).
 - Land-use change contributes to emissions.



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II. Consequences of Climate Change

1. Environmental Impacts:

- **Rising Temperatures:** Global average temperature has already increased by $\sim 1.1^{\circ}\text{C}$ since pre-industrial times.
- **Melting of Glaciers and Polar Ice:** Leads to sea-level rise and loss of habitat.
- **Sea Level Rise:** Inundation of coastal areas and small islands.
- **Extreme Weather Events:** Heatwaves, floods, droughts, and cyclones have become more intense and frequent.
- **Ocean Acidification:** CO_2 absorption lowers ocean pH, affecting marine life.

2. Economic Impacts:

- **Agricultural Losses:** Crop failure due to erratic rainfall and droughts.
- **Infrastructural Damage:** Flooding and cyclones destroy property and assets.
- **Increased Disaster Relief Costs.**

3. Social and Health Impacts:

- **Food and Water Insecurity.**
- **Vector-borne Diseases:** Malaria, dengue, etc., increase due to warmer climates.
- **Climate Refugees:** Displacement due to sea-level rise and disasters.



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4. Biodiversity Loss:

- Habitat shifts and extinctions, especially in sensitive ecosystems like coral reefs, Arctic regions, and tropical forests.

III. Mitigation Strategies (Reducing GHG Emissions)

1. Energy Transition:

- Shift from fossil fuels to **renewable energy**: solar, wind, hydro, bioenergy.
- Promote **energy efficiency** in buildings, industry, and transport.

2. Carbon Sequestration:

- **Afforestation/Reforestation**.
- **Carbon capture and storage (CCS)** technologies.

3. Green Transportation:

- Promote **electric vehicles**, public transport, and non-motorized transport (cycling, walking).

4. Sustainable Agriculture:

- Precision farming, organic farming, and **reduced fertilizer use**.
- **Methane-reducing practices** in livestock rearing.



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5. Circular Economy:

- Reduce, reuse, recycle to cut emissions and resource use.
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IV. Adaptation Strategies (Coping with Impacts)

1. Disaster-Resilient Infrastructure:

- Flood defenses, cyclone shelters, climate-proof buildings.

2. Climate-Smart Agriculture:

- Drought-resistant crops, efficient irrigation, crop insurance.

3. Water Resource Management:

- Rainwater harvesting, watershed management, desalination.

4. Early Warning Systems:

- Real-time weather forecasting and disaster response mechanisms.

5. Ecosystem-Based Approaches:

- Mangrove restoration, wetland conservation to buffer storms and floods.



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V. Global Initiatives

1. Paris Agreement (2015):

- Legally binding agreement under UNFCCC.
- Aim: Limit global temperature rise to **well below 2°C**, preferably **1.5°C**.
- **Nationally Determined Contributions (NDCs)**: Voluntary emission targets submitted by countries.
- Focus on **mitigation, adaptation, finance**, and **transparency**.
- Developed countries pledged **\$100 billion/year** by 2020 to support developing nations.

2. Intergovernmental Panel on Climate Change (IPCC):

- **UN body** for assessing climate science.
- Publishes **Assessment Reports (ARs)** (latest: AR6, 2021–2023).
- AR6 highlights:
 - Climate change is unequivocally human-induced.
 - Some changes are irreversible.
 - Immediate deep cuts in GHGs can stabilize warming.

3. UNFCCC (United Nations Framework Convention on Climate Change):

- Established in 1992 (Rio Earth Summit).
- Parent treaty of Paris Agreement and Kyoto Protocol.



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4. Kyoto Protocol (1997):

- First international treaty to set binding GHG emission targets for developed countries.
- Introduced market mechanisms like **Clean Development Mechanism (CDM)**.

5. Global Climate Funds:

- **Green Climate Fund (GCF)**: Supports developing countries in mitigation/adaptation.
- **Adaptation Fund, Global Environment Facility (GEF)** also provide financial support.

VI. India's Climate Initiatives

- **National Action Plan on Climate Change (NAPCC)**: 8 missions including:
 - National Solar Mission
 - National Mission on Sustainable Agriculture
 - National Electric Mobility Mission
- **State Action Plans on Climate Change (SAPCCs)**.
- **International Solar Alliance (ISA)**: India-led initiative to promote solar energy globally.
- Updated **NDCs** (2022): Net zero by **2070**, reduce emissions intensity by 45% by 2030 (from 2005 levels), 50% energy from non-fossil sources.