

1. INTRODUCTION TO THE CLIMATE CRISIS

Gariyashi Tamuly¹, Dr. Atheek Ur Rehaman HM², Vishal O. KohirePatil³

¹Subject Matter Specialist, Agrometeorology

Krishi Vigyan Kendra, Baksa, Assam Agricultural University.

²Scientist Agronomy

AICRP on Pigeonpea,

University of Agricultural Sciences, Bangalore,

³Department of Agronomy

MGM Nanasaheb Kadam College of Agriculture, Gandheli Chhatrapati Sambhajanagar.

Abstract

The climate crisis is a rapidly escalating global issue primarily driven by human activities that have significantly increased the concentration of greenhouse gases (GHGs) in the atmosphere. This chapter examines the science behind climate change, with a focus on key greenhouse gases, including carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), and their roles in global warming. It examines how human activities, including the burning of fossil fuels, deforestation, and industrial agriculture, have altered the natural balance of the Earth's atmosphere, leading to a rise in global temperatures. The chapter also highlights the urgent need for global action, discussing the impacts of climate change on weather patterns, ecosystems, and human health, as well as the social and economic consequences. It underscores the importance of limiting global temperature rise through international agreements such as the Paris Agreement, while emphasizing the critical role of sustainable practices, renewable energy, and collective efforts in mitigating the crisis. This chapter aims to provide readers with an in-depth understanding of the climate crisis, its causes, and the pathways to a more sustainable and resilient future.

The Science behind the Climate Crisis

Climate change is a global phenomenon that is driven primarily by human activities, which have significantly increased the concentration of greenhouse gases (GHGs) in the atmosphere. Carbon dioxide (CO₂) is the most prevalent greenhouse gas, contributing to approximately 75% of global warming. Methane (CH₄) and nitrous oxide (N₂O), although present in smaller quantities, are far more potent, with methane being over 28 times more effective at trapping heat over 100 years.

According to the Intergovernmental Panel on Climate Change (IPCC), global temperatures have already risen by approximately 1.1°C since pre-industrial times (1850-1900), with much of this increase occurring in recent decades. The World Meteorological Organization (WMO) reported that the past decade was the hottest on record, underscoring the acceleration of climate change.

The Role of Greenhouse Gases

Greenhouse gases are essential to maintaining life on Earth. Without them, the planet would be far too cold to support the ecosystems that sustain human civilization. Under natural conditions, these gases allow sunlight to enter and warm the Earth, while reflecting some heat back into space. This balance between incoming energy from the sun and outgoing infrared radiation is what maintains a stable climate.

However, the rapid rise in greenhouse gas concentrations due to human activities has tipped this natural balance. Carbon dioxide (CO₂) is the most significant contributor to global warming, accounting for about 75% of the warming effect. CO₂ is primarily released through the burning of fossil fuels (such as coal, oil, and natural gas) for electricity generation, transportation, and industrial processes. Deforestation also contributes to rising CO₂ levels, as forests act as carbon sinks by absorbing CO₂ from the atmosphere. When forests are cut down or burned, not only is this carbon storage capacity lost, but the carbon stored in trees is released back into the atmosphere.

While CO₂ is the most prevalent greenhouse gas, others are even more potent. Methane (CH₄), for example, is present in much smaller quantities but has a far stronger warming effect. Over 100 years, methane is 28 times more effective at trapping heat than CO₂. Methane is emitted during the production and transport of coal, oil, and natural gas, as well as from agricultural practices, particularly livestock farming, where it is released as a byproduct of digestion in ruminant animals such as cows. Methane is also emitted from landfills and the decay of organic waste. Another potent greenhouse gas is nitrous oxide (N₂O), which is 265 times more effective at trapping heat than CO₂ over 100 years. N₂O is primarily released from agricultural activities, especially the use of synthetic fertilizers and manure management. It can also be emitted during industrial processes and from the combustion of fossil fuels.

Table.1.1: Greenhouse Gas Concentration over Time

<i>Year</i>	<i>CO₂ (ppm)</i>	<i>CH₄ (ppb)</i>	<i>N₂O (ppb)</i>
<i>1850</i>	<i>280</i>	<i>722</i>	<i>270</i>
<i>1900</i>	<i>295</i>	<i>798</i>	<i>285</i>
<i>1950</i>	<i>310</i>	<i>1062</i>	<i>300</i>
<i>2000</i>	<i>370</i>	<i>1770</i>	<i>314</i>
<i>2020</i>	<i>414</i>	<i>1860</i>	<i>334</i>

**This table shows the increase in concentrations of CO₂, CH₄, and N₂O in the atmosphere from 1850 to 2020.*

Historical Context

Earth's climate has naturally fluctuated over millions of years, with the planet experiencing long periods of warming and cooling. However, these shifts occurred over thousands of years, allowing ecosystems and species to adapt. The current rate of warming is unprecedented. The IPCC's 2018 Special Report on global warming emphasized that we have only 12 years to limit the increase in global temperatures to 1.5°C above pre-industrial levels to prevent catastrophic impacts on ecosystems, economies, and human health.

The Industrial Revolution (beginning in the late 18th century) marked a significant turning point, with the large-scale burning of coal, the rise of factory production, and the expansion of transportation. Between 1880 and 2019, the global temperature rose by approximately 0.8°C, and since 1970, global CO2 emissions have more than doubled, further exacerbating the effects of global warming.

Global Impact: Weather Extremes and Environmental Change

The climate crisis is reshaping the planet in profound ways, with weather extremes and environmental changes becoming increasingly evident. These impacts are not isolated; they are interconnected, amplifying risks to ecosystems, human societies, and economies. This section delves into the global consequences of the climate crisis, focusing on the rise of extreme weather events and the transformation of natural environments.

Effects on Weather Patterns

Heatwaves

Heatwaves are becoming more frequent, intense, and prolonged due to rising global temperatures. These extreme heat events pose serious risks to human health, agriculture, and infrastructure. For example:

- ***Health risks:*** Heatwaves can cause heatstroke, dehydration, and exacerbate cardiovascular and respiratory conditions, particularly among vulnerable populations like the elderly and children.
- ***Agricultural impacts:*** Prolonged heat can reduce crop yields, threaten livestock, and strain water resources, leading to food shortages and economic losses.
- ***Energy demand:*** Increased use of air conditioning during heatwaves drives up energy consumption, often leading to power outages and higher greenhouse gas emissions.

Droughts

Climate change is altering precipitation patterns, leading to more frequent and severe droughts in many regions. Droughts have far-reaching consequences, including:

- ***Water scarcity:*** *Reduced rainfall and shrinking water supplies affect drinking water availability, irrigation for agriculture, and industrial processes.*
- ***Desertification:*** *Prolonged droughts can degrade soil quality, turning fertile land into deserts and displacing communities.*
- ***Wildfires:*** *Dry conditions increase the risk of wildfires, which destroy ecosystems, property, and lives while releasing large amounts of CO₂ into the atmosphere.*

Floods

While some regions face droughts, others experience increased rainfall and flooding. Climate change intensifies the water cycle, leading to:

- ***Heavy rainfall events:*** *Warmer air holds more moisture, resulting in more intense and frequent downpours.*
- ***Urban flooding:*** *Poorly designed infrastructure and urbanization exacerbate flood risks in cities, causing damage to homes, businesses, and transportation networks.*
- ***River and coastal flooding:*** *Rising sea levels and overflowing rivers threaten communities, particularly in low-lying areas.*

Rising Sea Levels and Coastal Erosion

Causes of Rising Sea Levels

Global sea levels are rising due to two primary factors:

1. ***Thermal expansion:*** *As ocean water warms, it expands, taking up more space.*
2. ***Melting ice:*** *Glaciers and ice sheets in Greenland and Antarctica are melting at an accelerating rate, adding water to the oceans.*

Impacts on Coastal Communities

Rising sea levels and coastal erosion have devastating effects:

- **Displacement:** Millions of people living in coastal areas are at risk of losing their homes and livelihoods.
- **Infrastructure damage:** Roads, bridges, and buildings are increasingly vulnerable to flooding and erosion.
- **Saltwater intrusion:** Rising seas can contaminate freshwater supplies, affecting drinking water and agriculture.

Threats to Ecosystems

Coastal ecosystems, such as mangroves, coral reefs, and wetlands, are under threat from rising seas. These ecosystems provide critical services, including storm protection, habitat for marine life, and carbon sequestration. Their loss would have cascading effects on biodiversity and human well-being.

Increased Frequency and Severity of Storms and Natural Disasters

Hurricanes and Cyclones

Warmer ocean temperatures provide more energy for storms, leading to:

- **Stronger storms:** Hurricanes and cyclones are becoming more intense, with higher wind speeds and heavier rainfall.
- **Increased destruction:** These storms cause widespread damage to infrastructure, displace communities, and result in significant economic losses.

Tornadoes and Severe Storms

While the link between climate change and tornadoes is complex, evidence suggests that changing atmospheric conditions may increase the likelihood of severe storms in certain regions.

Wildfires

Climate change exacerbates wildfire risks by creating hotter, drier conditions. Wildfires:

- **Destroy ecosystems:** Forests, grasslands, and wildlife habitats are lost, disrupting biodiversity.

- **Release carbon:** Burning vegetation releases stored carbon, contributing to further warming.
- **Impact air quality:** Smoke from wildfires poses serious health risks, particularly for those with respiratory conditions.

Impact on Biodiversity and Ecosystems

Habitat Loss

Rising temperatures, changing precipitation patterns, and extreme weather events are altering habitats worldwide. Species that cannot adapt or migrate face extinction, leading to a loss of biodiversity.

Ocean Acidification

Increased CO₂ levels are not only warming the planet but also acidifying the oceans. This process:

- **Threatens marine life:** Coral reefs, shellfish, and other marine organisms struggle to build and maintain their calcium carbonate structures.
- **Disrupts food chains:** Changes in ocean chemistry affect the entire marine ecosystem, from plankton to fish and marine mammals.

Shifting Ecosystems

As temperatures rise, ecosystems are shifting poleward or to higher altitudes. This migration:

- **Creates mismatches:** Species that rely on each other for survival may not migrate at the same rate, disrupting ecological relationships.
- **Introduces invasive species:** Warmer temperatures allow invasive species to thrive in new areas, outcompeting native species.

Social and Economic Consequences of Climate Change

The social and economic effects of the climate crisis are far-reaching. Agriculture, a primary source of livelihood for billions of people, is particularly vulnerable to climate change. The Intergovernmental Panel on Climate Change (IPCC) projects that by 2050, climate change will reduce global crop yields by 10-25% for staple

crops like wheat, maize, and rice, potentially resulting in food insecurity for millions.

- ***Water Scarcity:*** *According to the United Nations (UN), over 2 billion people already live in regions experiencing high water stress, and climate change is expected to worsen the situation. By 2030, it is estimated that half of the world's population will be living in water-stressed areas.*
- ***Health Risks:*** *Rising temperatures contribute to the spread of infectious diseases. The World Health Organization (WHO) has warned that by 2030, the impact of climate change could cause an additional 250,000 deaths per year due to heat stress, malnutrition, and diseases like malaria and dengue.*

The Urgency of Climate Action

The urgency of climate action cannot be overstated. According to the IPCC's 2018 Special Report, to limit global temperature rise to 1.5°C, global carbon emissions must be reduced by 45% by 2030, compared to 2010 levels, and reach net-zero emissions by 2050. Achieving these targets requires a global shift towards clean energy, improved energy efficiency, and sustainable land-use practices.

The United Nations Framework Convention on Climate Change (UNFCCC) estimates that climate-related disasters now cost the global economy more than \$520 billion annually, and without swift intervention, this figure is likely to rise. However, action taken now can reduce future economic and environmental losses and unlock new opportunities in the green economy, including renewable energy, sustainable agriculture, and eco-friendly technologies.

What's at Stake: A Call to Action

The stakes are high, and the path forward requires cooperation across borders and sectors. The Paris Agreement, adopted in 2015 by nearly 200 countries, represents the global commitment to limit global warming to well below 2°C, with efforts to limit it to 1.5°C. However, achieving these goals requires strong commitments from

both governments and industries, along with sustained efforts by individuals and local communities.

It is not just about mitigation—reducing emissions and preventing further damage—but also adaptation—adjusting our infrastructure, agriculture, and societal structures to cope with the unavoidable impacts of climate change.

Conclusion

The climate crisis is not a distant threat—it is here now, with profound effects on ecosystems, economies, and communities worldwide. As the data shows, the window for decisive action is narrowing. If we are to avert the worst consequences of global warming, immediate and collective action is necessary. Governments, businesses, and individuals must all play their part in shaping a sustainable future. This book will explore not only the causes and impacts of climate change but also the critical solutions and pathways available to ensure that we can transition to a more sustainable, resilient world for future generations.

References

1. Intergovernmental Panel on Climate Change (IPCC). (2018). *Global Warming of 1.5°C: An IPCC Special Report*. Intergovernmental Panel on Climate Change. Retrieved from <https://www.ipcc.ch/sr15/>
2. World Meteorological Organization (WMO). (2020). *State of the global climate 2020*. WMO. Retrieved from <https://public.wmo.int/en/our-mandate/climate>
3. United Nations Framework Convention on Climate Change (UNFCCC). (2019). *The Paris Agreement*. UNFCCC. Retrieved from <https://unfccc.int/process-and-meetings/the-paris-agreement>
4. World Health Organization (WHO). (2018). *Climate change and health*. WHO.
5. United Nations (UN). (2020). *Water Scarcity*. UN. National Oceanic and Atmospheric Administration (NOAA). (2020). *Climate Change: Atmospheric Carbon Dioxide*. NOAA. Retrieved from