

Green House Effect, Climate Change and Kyoto Protocol

Green House Effect

Progressive warming up of the earth's surface due to blanketing effect of man-made CO₂ and other greenhouse gases (CH₄), N₂O, H₂O(V) etc. which are responsible for this phenomenon is known as greenhouse gases.

The GHG effect is a naturally occurring process that aids the heating of the earth's surface and atmosphere. It results from the fact that certain atmospheric gases such as CO₂, H₂O (vapour), CH₄, etc. are capable of changing the energy balance of the planet by being able to absorb long wave radiation (IR) from the earth's surface (infra-red radiations). The term 'green house' is used to describe this phenomenon since these gases act like the glass of green house to trap heat and maintain higher interior temperatures than would normally occur.

Without the greenhouse effect, it is not possible to sustain life on this planet as the average temperature of the earth would be below freezing. The average temperature on Earth is about 61 degrees F (16deg Celcius) because of the greenhouse effect.

<https://www.youtube.com/watch?v=066-eumKxS8>

A similar phenomenon takes place in a car parked outside on a cold, sunny day. Incoming solar radiation warms the car's interior, but outgoing thermal radiation is trapped inside the car's closed windows.

Global warming: can be defined as a gradual increase in the overall temperature of the earth's atmosphere generally attributed to the greenhouse effect caused by increased levels of carbon dioxide, CFCs, and other pollutants.

Global Warming Potential: The potential of a greenhouse gas to cause warming is expressed by GWP. GWP is a relative measure of how much heat a greenhouse gas traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of CO₂.

CO₂=1 {in100 YEARS }

CH₄=21

N₂O=310

Causes of global warming: It is caused by increased concentrations of greenhouse gases in the atmosphere, mainly from human activities such as burning fossil fuels, deforestation and farming. In its Fifth Assessment Report, the Intergovernmental Panel on Climate Change, a group of 1,300 independent scientific experts from countries all over the world under the auspices of the United Nations, concluded there's a more than 95 percent probability that human activities over the past 50 years have warmed our planet.

The industrial activities that our modern civilization depends upon have raised atmospheric carbon dioxide levels from 280 parts per million to 412 parts per million in the last 150 years. The panel also concluded there's a better than 95 percent probability that human-produced greenhouse gases such as carbon dioxide, methane and nitrous oxide have caused much of the observed increase in Earth's temperatures over the past 50 years.

Effects of Global Warming

For well over a century it has been widely known that CO₂ absorbs infra-red light reflected from the earth's surface then re-emits it, much of it back to the surface. The higher the concentration of CO₂ in the atmosphere, the warmer the surface temperature gets, a phenomenon known as global

warming which has a number of effects including 1. ocean warming, 2. loss of land-based ice and permafrost, 3. climate change which becomes less predictable and 4. sea level rise. Below is an outline of these effects.

1. Water Resources:

Ocean Warming

Most of the additional heat generated by rising levels of CO₂ in the atmosphere is absorbed by the oceans. As a result, sea surface temperature is rising and already causing:

Thermal Expansion: As its temperature increases, seawater expands, contributing to sea level rise, changes in ocean circulation and higher seabed water temperature which may be damaging and can cause coastal erosion, arctic erosion etc.

Coastal Erosion: Rise in sea level, combined with other factors such as stronger wind events and loss of natural barriers protecting the coastline, result in increased coastal erosion endangering infrastructure, buildings and other facilities located in close proximity to the coastline.

Arctic Erosion: The Arctic ocean is warming, resulting in stronger storm activity and reduced sea ice formation, both contributing to erosion of coastlines. This causes increased exposure and thawing of methane (CH₄) bearing sediments and resulting in emission of this gas and its oxidation to CO₂, contributing to its rising presence in the atmosphere and further global warming.

Warmer bottom water: This is accelerating melting of ice enabling faster flow from glaciers discharging to the oceans and erosion of the marine ice sheet covering the West Antarctic archipelago – both causing sea level rise to accelerate and reducing stability of the ice sheet.

Coral Die-off: Reefs comprise a great variety of corals often growing in relatively shallow water. Coral reefs are weakened by human pollution making them susceptible to predation but are severely stressed or killed by seawater temperature rising by 2C. Their loss exposes adjacent coastlines, often low-lying, to erosion and flooding, destroys fish habitat and reduces fish catch for human consumption.

2. Ice Loss

Mountain glaciers store water which flows into rivers on which human populations depend for potable water, irrigation, food production, transport and generating energy, often in areas of dense population. These glaciers are storing less water and melting more rapidly so that in the future sufficient water may not be available for an expanding human population and its increasing demand for food and potable water.

Permafrost: Vast areas of land in the Arctic contain partly decomposed biota, sediments containing CH₄ produced from biota decomposition. These lands are permanently frozen but global warming produces surface temperatures which result in it melting more rapidly and to greater depth. As it melts, it exposes biota which thaws, resuming decomposition and producing CH₄ much of which is converted to CO₂ through oxidation by methanotrophic bacteria, then emitted to the atmosphere.

Land Subsidence: Buildings and infrastructure built on permanently frozen land, particularly in Russia and Alaska, is put at risk when warming surface temperature causes permafrost to thaw and the land to subside.

Polar Ice Sheets: Global warming causes the surface of the Greenland Ice Sheet to melt more rapidly, resulting in rivers flowing on its surface, terminating in moulins through which they drain to bedrock. This intensely cold water lubricates the underside of the ice-sheet making it more mobile,

before draining into the North Atlantic where it contributes to disruption of overturning circulation and flow of the Gulf Stream.

Ice Melt: Disruption of overturning circulation traps warmer water on the seabed causing the West Antarctic marine ice sheet to melt at its base, contributing to its instability. Warm seawater penetrates polar glaciers eroding ice blockages, enabling glaciers to discharge ice at faster rates resulting in ice sheets becoming less stable, as evidenced in Greenland and West Antarctica. This contributes to faster sea level rise which increases the risk of coastal erosion and flooding.

3. Climate Change

The temperature of the troposphere is now slightly under 1°C above the pre-industrial and is continuing to rise due to increasing emission of greenhouse gasses. This warming is characterised by less predictable, increasingly severe weather events, which include the following:

Temperatures: temperature extremes are setting new record highs and fewer days of extreme cold, though these do occur in the northern hemisphere due to distortion of the polar vortex.

Droughts: affecting farmland and habitat are becoming longer lasting – in many cases lasting over 5 years and reducing river flows.

Evaporation: Increased evaporation of water from soil and lakes occurs because the troposphere is getting warmer and able to hold more water in the form of vapour.

Wind Events such as cyclones and tornados may be less frequent but are more powerful and destructive, their strength increased by rising sea surface temperature.

Rainfall: In some areas rainfall has become less frequent but heavier and of longer duration, while hail storms have become more severe, often with larger hail stones.

On-going global warming will cause these events to become more frequent, last longer and become more severe. Alone or in combination they will continue to cause increasing damage to the environment in the following ways:

Rising temperatures are the principal cause of coral reefs dying, the loss of fish habitat and the protection they provide to low-lying coastal land from erosion by ocean wave action, making them vulnerable to flooding. On-shore temperature extremes are already setting new record highs resulting in declining food production and premature deaths.

Droughts and evaporation of surface water produce similar effects, converting some food bowls to dust bowls, increasing the rate of desertification and killing flora and fauna. Droughts in some parts of Australia have lasted over 8 years, causing rivers to run dry, preventing crop sowing, forcing destocking and overland transport of water to enable survival of town populations.

Combined, these events result in ferocious bushfires which are increasingly difficult to control, causing huge losses of trees, vegetation, fauna and property – including livestock – all becoming more and more costly to replace, more often forcing abandonment. They also enable pathogens and pests such as mountain pine beetles to invade and kill millions of trees and the spread of vectors carrying human diseases into areas hitherto free of them.

Wind events, often accompanied by heavy rainfall, are becoming more frequent and often result in flooding, loss of human life, damage to property, the environment and crop losses. They produce tidal surges which erode coastlines and flood low lying land.

4. Sea Level Rise

We know that thermal expansion caused by ocean warming and loss of mass from ice sheets and glaciers are the primary causes of sea level rise. Less certain is the speed with which these causes take effect.

Many climate scientists specialising in this area, notably those contributing to IPCC Assessment Reports, are of the view that these are relatively slow processes indicating sea level rise of 0.52-0.98 metres by 2100.

Conclusions

For more than fifty years, climate scientists have warned that continued emission of greenhouse gasses into the atmosphere, particularly CO₂, would result in climate change and if average global temperature rises by more than 1.5°C. above pre-industrial levels, those changes would be dangerous. If average global temperature rises by more than 2°C climate changes could become catastrophic, threatening most life on the planet. If we continue to ignore these warnings, we do so at our peril. In practice we have ignored them.

There is only one way of averting the outcomes described above and that is by stopping all use of fossil fuels over the next 10-20 years, improving the ability of natural carbon sinks and new technology to absorb CO₂ from the atmosphere. Transition to a decarbonised economy can be achieved within this time frame and, in the process, renewable energy required by the human population could become unlimited in its availability, rather than a constraint on innovation.

There is a price to pay for achieving this. The price is to reduce demand for fossil fuels to meet our energy needs and replace them with renewable energy.

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Climate Change

Difference between weather and climate:

Weather describes the conditions of atmosphere at a certain place and time with reference to temperature, pressure humidity etc.

Climate is the average weather pattern in a place over many years, almost 30 years.

Climate Change: refers to the change in the state of climate that can be identified by change in the mean or variability of properties and that persists for extended period, typically decades or longer.

IPCC (Intergovernmental Panel on Climate Change) Recognising the problem of potential global climate change, the world meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change in 1988.

IPCC has identified six GHGs.

- CO₂
- CH₄
- N₂O
- HFCs (hydrofluorocarbons)

- SF₆ (Sulphur hexafluoride)
- PFCs (Perfluorocarbons)

The IPCC findings spurred governments to create the United Nation Framework Convention on Climate Change (UNFCCC), which came into force in 1994. The Convention sets an overall framework for intergovernmental efforts to tackle the challenges posed by climate change.

IPCC, 1995 report concluded

- Global warming was happening
- Human activity was causing it
- Global warming was likely to unleash unnatural, devastating floods, storms, heat waves, droughts etc.
- CO₂ emissions must be cut, particularly in the industrialized countries.

IPCC report (2007) says-

- Global temperature could rise up to 6 degree by 2100, triggering disaster for billions of people.

Climate actions have often fallen into one of two strategies:

1. mitigation efforts to lower or remove greenhouse gas emissions from the atmosphere, and
2. adaptation efforts to adjust systems and societies to withstand the impacts of climate change.

How to mitigate climate change?

These are some of the **mitigation measures** that can be taken to **avoid the increase of pollutant emissions**:

- Practice Energy efficiency
- Greater use of renewable energy
- Electrification of industrial processes
- Efficient means of transport implementation: electric public transport, bicycle, shared cars ...
- Carbon tax and emissions markets
- Adaptation to climate change:

In terms of **adaptation measures**, there are several actions that help **reducing vulnerability to the consequences of climate change**:

- More secure facility locations and infrastructures
- Landscape restoration (natural landscape) and reforestation
- Flexible and diverse cultivation to be prepared for natural catastrophes
- Research and development on possible catastrophes, temperature behavior, etc.

- Preventive and precautionary measures (evacuation plans, health issues, etc.)

Impacts of Climate Change:

- **Water**

Changes to water resources can have a big impact on people's lives. In many regions, floods and water quality problems are likely to be worse because of climate change.

- **Food**

Our food supply depends on climate and weather conditions. Although agricultural practices may be adaptable, changes like increased temperatures, water stress, diseases, and weather extremes create challenges for the farmers

- **Health**

Human health is vulnerable to climate change. The changing environment is expected to cause more heat stress, an increase in waterborne diseases, poor air quality, and diseases transmitted by insects and rodents. Extreme weather events can compound many of these health threats. Impacts include the direct effects of extreme weather, leading to injury and loss of life and indirect effects, such as undernutrition brought on by crop failures. Various infectious diseases are more easily transmitted in a warming climate, such as dengue fever, which affects children most severely, and malaria .

- **The environment**

Ecosystems are also affected by climate change. Habitats are being modified, the timing of events such as flowering and egg laying are shifting, and species are altering their home ranges.

Changes are also occurring to the ocean. The ocean absorbs about 30% of the carbon dioxide that is released into the atmosphere from the burning of fossil fuels. As a result, the ocean is becoming more acidic, affecting marine life. Rising sea levels due to thermal expansion and melting land ice sheets and glaciers put coastal areas at greater risk of erosion and storm surge.

- **Livelihoods, industry, and infrastructure**

In small islands and mega deltas, inundation from sea level rise is expected to threaten vital infrastructure and human settlements. This could lead to homelessness in countries with low-lying areas such as Bangladesh, as well as statelessness for populations in island nations, such as the Maldives and Tuvalu. Climate change can be an important driver of migration, both within and between countries.

Impact of Climate Change in India

Please refer to the link below

<https://www.livemint.com/news/india/the-growing-threat-of-climate-change-in-india-1563716968468.html>

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Average temperatures in India have been on the rise

Climate change hurts all farmers but those without irrigation are particularly vulnerable

Climate Change and Food Security:

Climate change will impact agriculture and food production around the world due to the effects of elevated CO₂ in the atmosphere; higher temperatures; altered precipitation and transpiration regimes; increased frequency of extreme events; and modified weed, pest, and pathogen pressure

Food availability

As of 2019, negative impacts have been observed for some crops in low-latitudes (maize and wheat), while positive impacts of climate change have been observed in some crops in high-latitudes (maize, wheat, and sugar beets). In many areas, fisheries have already seen their catch decrease because of global warming and changes in biochemical cycles. In combination with overfishing, warming waters decrease the maximum catch potential

Other aspects of food security

Climate change impacts depend strongly on projected future social and economic development. As of 2019, an estimated 831 million people are undernourished. Under a high emission scenario (RCP6.0), cereals are projected to become 1-29% more expensive in 2050 depending on the socioeconomic pathway, particularly affecting low-income consumers. Compared to a no climate change scenario, this would put between 1-181 million extra people at risk of hunger.

While CO₂ is expected to be good for crop productivity at lower temperatures, it does reduce the nutritional values of crops, with for instance wheat having less protein and less of some minerals. It is difficult to project the impact of climate change on volatility of food prices and use, but most models projecting the future indicate that prices will become more volatile.

Droughts and agriculture

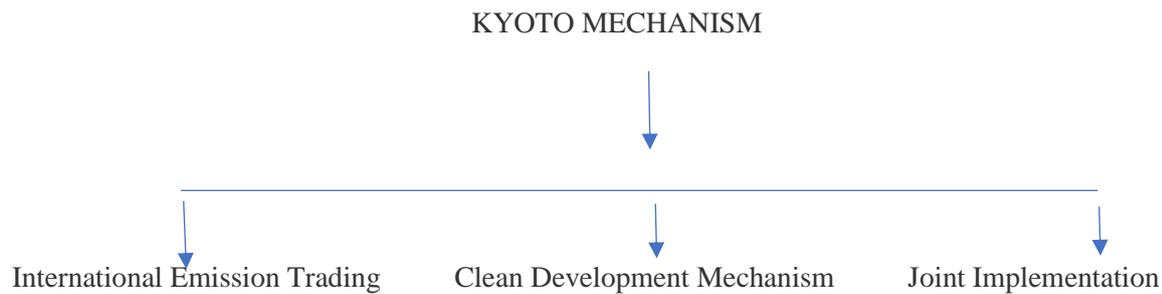
Some evidence suggests that droughts have been occurring more frequently because of global warming; and they are expected to become more frequent and intense in Africa, southern Europe, the Middle East, most of the Americas, Australia, and Southeast Asia. However, other research suggests that there has been little change in drought over the past 60 years. Their impacts are aggravated because of increased water demand, population growth, urban expansion, and environmental protection efforts in many areas. Droughts result in crop failures and the loss of pasture for livestock.

Climate change accords

Kyoto Protocol (1997)

- The Kyoto Protocol is an international agreement to reduce the GHG emissions. It was negotiated under UNFCCC (United Nations Convention on Climate Change), during a meeting held in Kyoto, Japan in 1997.
- It encouraged industrialized countries to stabilize GHGs (Green House Gases) emissions.
- The protocol came into force in 2005
- It is a legal binding agreement under which industrialised countries will reduce their collective emissions of GHGs by 5.2% compared to the year 1990.

- The goal is to lower overall emissions from 6 GHGs.
- Kyoto's first commitment period is from 2008 to 2012
- Recognizing the developed countries are principally responsible for the current high levels of GHG emissions in the atmosphere as a result of more than 150 years of industrial activity, the protocol places heavier burden on developed nation under the principle of common but differentiated responsibility



Second Commitment period: Parties committed to reduce GHG emissions by atleast 18% below 1990 levels in the 8 years period (2013-2020)

PARIS AGREEMENT, 2015

2015 was a historic year in which 196 parties came together under Paris Agreement to transform their development trajectories so that they set the world on a course towards sustainable development.

Through Paris Agreement parties agreed to a long-term goal for adaptation-to increase the ability to adapt to the adverse climate change and foster climate resilience and low GHG emissions, in a manner that does not threaten food production.

- Nationally Determined Contributions (NDCs)- were decided to be adopted by the parties. NDCs embody efforts of each country to reduce national emissions and adapt to the impacts of climate change.
- Green Climate Fund- was also decided to finance for climate change adaptations and mitigation to underdeveloped and developing nations.
- Paris Agreement: is to strengthen the global response to threat climate change by keeping a global temperature rise of this century well below 2 degree Celsius above pre-industrial level and to pursue efforts to limit the temperature increase even further to 1.5 degree Celsius.

What is a carbon footprint?

It measures the total GHG emissions caused directly and indirectly by a person, organization, event, product or country.

Mitigation and Adaptation in India

National Action Plan on Climate change (India)

The National Action Plan on Climate change was formally launched on June 30th, 2008. The NAPCC identifies measures that promote development objectives while also yielding co-benefits for addressing climate change effectively. There are eight "National Missions" which form the core of the National

action plan. They focus on promoting understanding of climate change, adaptation and mitigation, energy efficiency and natural resource conservation.”

The eight missions are:

- National Solar Mission
- National Mission for Enhanced Energy Efficiency
- National Mission on Sustainable Habitat
- National Water Mission
- National Mission for Sustaining the Himalayan Ecosystem
- National Mission for a Green India
- National Mission for Sustainable Agriculture
- National Mission on Strategic Knowledge for Climate Change

i. National Solar Mission

Great importance has been given to the National Solar Mission in the NAPCC. The objective of the mission is to increase the share of solar energy in the total energy mix of the country, while also expanding the scope of other renewable sources. The mission also calls for the launch of a research and development (R&D) programme that, with the help of international cooperation, would look into creating more cost-effective, sustainable and convenient solar power systems.

The NAPCC sets the solar mission a target of delivering 80% coverage for all low temperature (<150° C) applications of solar energy in urban areas, industries and commercial establishments, and a target of 60% coverage for medium temperature (150° C to 250° C) applications. The deadline for achieving this is the duration of the 11th and 12th five-year plans, through to 2017. In addition, rural applications are to be pursued through public-private partnership.

The NAPCC also sets the target of 1000 MW/annum of photovoltaic production from integrated facilities by 2017 as well as 1000 MW of Concentrating Solar Power generation capacity.

ii. National Mission for Enhanced Energy Efficiency

The Government of India already has a number of initiatives to promote energy efficiency. In addition to these, the NAPCC calls for:

- Mandating specific energy consumption decreases in large energy consuming industries and creating a framework to certify excess energy savings along with market based mechanisms to trade these savings.
- Innovative measures to make energy efficient appliances/products in certain sectors more affordable.
- Creation of mechanisms to help finance demand side management programmes by capturing future energy savings and enabling public-private-partnerships for this.
- Developing fiscal measures to promote energy efficiency such as tax incentives for including differential taxation on energy efficient certified appliances.

iii. National Mission on Sustainable Habitat

The aim of the Mission is to make habitats more sustainable through a threefold approach that includes:

- Improvements in energy efficiency of buildings in residential and commercial sector
- Management of Municipal Solid Waste (MSW)
- Promote urban public transport

iv. National Water Mission

The National Water Mission aims at conserving water, minimizing wastage and ensuring more equitable distribution through integrated water resource management. The Water Mission will develop a framework to increase the water use efficiency by 20%. It calls for strategies to tackle variability in rainfall and river flows such as enhancing surface and underground water storage, rainwater harvesting and more efficient irrigation systems like sprinklers or drip irrigation.

v. National Mission for Sustaining the Himalayan Ecosystem

The Plan calls for empowering local communities especially Panchayats to play a greater role in managing ecological resources. It also reaffirms the following measures mentioned in the National Environment Policy, 2006.

- Adopting appropriate land-use planning and water-shed management practices for sustainable development of mountain ecosystems
- Adopting best practices for infrastructure construction in mountain regions to avoid or minimize damage to sensitive ecosystems and despoiling of landscapes
- Encouraging cultivation of traditional varieties of crops and horticulture by promoting organic farming, enabling farmers to realize a price premium
- Promoting sustainable tourism based on best practices and multi-stakeholder partnerships to enable local communities to gain better livelihoods
- Taking measures to regulate tourist inflows into mountain regions to ensure that the carrying capacity of the mountain ecosystem is not breached
- Developing protection strategies for certain mountain scopes with unique “incomparable values”

vi. National Mission for a Green India

This Mission aims at enhancing ecosystem services such as carbon sinks. It builds on the Prime Minister’s Green India campaign for afforestation of 6 million hectares and the national target of increasing land area under forest cover from 23% to 33%. It is to be implemented on degraded forest land through Joint Forest Management Committees set up under State Departments of Forests. These Committees will promote direct action by communities.

vii. National Mission for Sustainable Agriculture

The aim is to make Indian agriculture more resilient to climate change by identifying new varieties of crops, especially thermal resistant ones and alternative cropping patterns. This is to be supported by integration of traditional knowledge and practical systems, information technology and biotechnology, as well as new credit and insurance mechanisms.

viii. National Mission on Strategic Knowledge for Climate Change

This Mission strives to work with the global community in research and technology development and collaboration through a variety of mechanisms and, in addition, will also have its own research agenda supported by a network of dedicated climate change related institutions and universities and a Climate Research Fund. The Mission will also encourage private sector initiatives for developing innovative technologies for adaptation and mitigation.

Implementation of Missions

The 8 National Missions are to be institutionalised by “respective ministries” and will be organised through inter-sectoral groups including, in addition to related Ministries, Ministry of Finance and the Planning Commission, experts from industry, academia and civil society.

Source: [Ministry of Environment and Forests, Government of India](#), on NAPCC