

Climate Change

- The Earth's climate has changed throughout History.
- In the last 650,000 years there have been Several cycles of glacial and warm periods each Lasting thousands or millions of years.
- Most of these climate changes are attributed to very small variations in earth's orbit that changes the amount of solar energy our planet receives.
- It is understood that at present the Earth's Climate is getting warmer which is referred to as 'Global Warming'.
- Earth's temperature has gone up about one degree Fahrenheit in the Last 100 years.
- This is a very small change but small changes in earth's temperature can have big effects.
- Some effects are already happening Such as melting of glaciers, rise in the level of Oceans, prolonged droughts, excessive rain and Floods, etc.

Causes of Climate Change:

It can be broadly divided into 2 categories-

- **Natural Cause**
- **Anthropogenic Causes**

Natural Cause:

- There are number of natural factor responsible for climate change.
- Some of the major ones are continental drift, volcanoes etc.

Continental Drift

- It suggests that glaciations are linked to continental drifting.
- The Ewing-Donn theory proposes that Pleistocene glaciations were initiated when the North Pole reached its present position in the middle of the Arctic Ocean, and Antarctica became coincident with the South Polar Region.
- These theories are based on the presumption that some 300 million years ago all the continents were joined together to form the super-continent 'Pangaea' which was located at high latitudes far to the south of their present position.

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- This revolutionary theory emerging from ecology explains how large fragments of glaciated terrain reached their scattered subtropical locations
- Since the plates move at a very slow rate of only a few centimetres per year, significant changes in the positions of continents occur over large scales of geological time. Therefore, large-scale climatic changes also happen in millions of years.

Volcanoes

- Volcanoes can impact climate change.
- During major explosive eruptions huge amounts of volcanic gas, water vapor, dust particle, and ash are injected into the stratosphere.
- Injected ash falls rapidly from the stratosphere - most of it is removed within several days to weeks - and has little impact on climate change.
- Volcanic gases like sulfur dioxide can cause global cooling, while volcanic carbon dioxide, a greenhouse gas, has the potential to promote global warming.
- Volcanic dust particles, deflects light of short wavelengths coming from the sun. But long wave terrestrial radiation can easily pass through volcanic dust without any loss and large-scale volcanic dust may lower down the earth's temperature to a certain extent.

Anthropogenic Causes

- Scientists, since the beginning of the 20th century, have studied the impact of climate change caused by human activities, such as emission of heat trapping gases (greenhouse gases) and changes in land use pattern that make land reflect more or less sunlight.

Greenhouse Effect & GHGs:

- The greenhouse effect is a process that occurs when gases in Earth's atmosphere trap the Sun's heat.
- This process makes Earth much warmer than it would be without an atmosphere.
- The greenhouse effect is one of the things that make the Earth a comfortable place to live.

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- As the name depicts, the greenhouse effect works like a greenhouse.
- A greenhouse is a building with glass walls and a glass roof.
- Greenhouses are used to grow plants, such as tomatoes and tropical flowers.
- A greenhouse stays warm inside, even during the winter.
- In the daytime, sunlight shines into the greenhouse and warms the plants and air inside.
- At night time, it's colder outside, but the greenhouse stays pretty warm inside.
- That's because the glass walls of the greenhouse trap the Sun's heat.
- The greenhouse effect works much the same way on Earth.
- Gases in the atmosphere, such as carbon dioxide, trap heat just like the glass roof of a greenhouse.
- These heat-trapping gases are called greenhouse gases.
- During the day, the Sun shines through the atmosphere.
- Earth's surface warms up in the sunlight.
- At night, Earth's surface cools, releasing heat back into the air. But some of the heat is trapped by the greenhouse gases in the atmosphere.
- That's what keeps our Earth a warm and cozy.

Greenhouse Gases (GHGs):

- Gases that trap heat in the atmosphere are called greenhouse gases.
- **Carbon dioxide (CO₂):**
 - Carbon dioxide enters the atmosphere through burning fossil fuels (coal, natural gas, and oil), solid waste, trees and other biological materials, and also as a result of certain chemical reactions (e.g., manufacture of cement).
 - Carbon dioxide is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.
- **Methane (CH₄):**
 - Methane is emitted during the production and transport of coal, natural gas, and oil.

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- Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.
- **Nitrous oxide (N₂O):** Nitrous oxide is emitted during agricultural and industrial activities, combustion of fossil fuels and solid waste, as well as during treatment of wastewater.
- **Fluorinated gases:**
 - Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulfur Hexafluoride (SF₆), and Nitrogen trifluoride (NF₃) are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes.
 - Fluorinated gases are sometimes used as substitutes for stratospheric ozone-depleting substances (e.g., chlorofluorocarbons, hydrochlorofluorocarbons, and halons).
 - These gases are typically emitted in smaller quantities, but because they are potent greenhouse gases, they are sometimes referred to as High Global Warming Potential gases.
- **Water vapour (H₂O):**
 - Water vapour is the biggest overall contributor to the greenhouse effect and humans are not directly responsible for emitting this gas in quantities sufficient to change its concentration in the atmosphere.
 - However, CO₂ and other greenhouse gases are increasing the amount of water vapour in the air by boosting the rate of evaporation.
- **Black Carbon:**
 - Black carbon is a potent climate-warming component of particulate matter formed by the incomplete combustion of fossil fuels, wood and other fuels.
 - Black carbon is a short-lived climate pollutant with a lifetime of only days to weeks after release in the atmosphere.

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- During this short period of time, black carbon can have significant direct and indirect impacts on the climate, glacial regions, agriculture and human health.
- **Brown Carbon:**
 - Brown carbon (light-absorbing organic carbon) has attracted interest as a possible cause of climate change.
 - This class of organic carbon, known for its light brownish colour, absorbs strongly in the ultraviolet wavelengths and less significantly going into the visible.
 - Types of brown carbon include breakdown products from biomass burning, a mixture of organic compounds emitted from soil, and volatile organic compounds given off by vegetation.
 - Brown carbon is generally referred for greenhouse gases and black carbon for particles resulting from impure combustion, such as soot and dust

Global Warming:

Gas	GWP (100-year)	Lifetime (years)
Carbon Dioxide	1	100
Methane	21	2
Nitrous Oxide	310	120
Hydrofluorocarbons (HFCs)	140-11,700	1-270
Perfluorocarbons (PFCs)	6,500-9,200	8000-50,000
Sulfur hexafluoride (SF6)	23,900	3,200

- Global warming is the long-term heating of Earth's climate system observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere.
- Since the pre-industrial period, human activities are estimated to have increased Earth's global average temperature by about 1 degree Celsius (1.8 degrees Fahrenheit), a number that is currently increasing by 0.2 degrees Celsius (0.36 degrees Fahrenheit) per decade.

- Most of the current warming trend is extremely likely (greater than 95 percent probability) the result of human activity since the 1950s and is proceeding at an unprecedented rate over decades to millennia.

Global Warming Potential (GWP)

- The Global Warming Potential (GWP) was developed to allow comparisons of the global warming impacts of different gases.
- Specifically, it is a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide (CO₂).
- The larger the GWP, the more that a given gas warms the Earth compared to CO₂ over that time period.
- The time period usually used for GWPs is 100 years.
- **Effects of climate change** – Scientists had Predicted in the past that the result from global Climate change are now occurring, loss of sea Ice, accelerated sea level rise and longer, more Intense heat waves.
 - **Temperatures will continue to rise** – Experts agree that greenhouse gases which Trap heat and prevent it from leaving the Earth's atmosphere are mostly responsible for the temperature spike.
 - **Frost- free season (and growing season) will lengthen** – it could actually have Detrimental effects on the crops we grow.
 - Warmer weather helps pests survive longer which can destroy crops.
 - Rising Temperatures are also expected to contribute to a shift in areas which are agriculturally most productive and the crops that grow there.
 - **Changes in precipitation patterns** – The Contrast between wet and dry areas will Increase globally. In other words, the wet Areas will get wetter and the dry areas will get drier.
 - **More droughts and heat waves** – With rising Temperatures and shifting rainfall patterns, Heat waves and droughts are increasing in Frequency and intensity.
 - **Sea level rise** – Scientists have determined that global sea level has been steadily rising since 1900 at a rate of at least 0.1 to 0.25 Centimetre per

year. Sea level can rise by two different mechanisms with respect to Climate change.

- **Arctic likely to become ice-free** – The Arctic Ocean is expected to become essentially ice Free in summer before mid-century. Response to Climate Change

There are two main responses to climate Change:

- **Mitigation** – which addresses the root causes of climate change, by reducing greenhouse Gas emissions.
- **Adaptation** – seeks to lower the risks posed by the consequences of climatic changes. Both approaches will be necessary to deal with the global changes that have already been set in motion.

Mitigation measures:

- It is important that we learn how to reduce Climate change, and put them into practice now, before it is too late.
- **Cleaner alternative energy sources:** One important way to fight climate change is to Reduce our reliance on and usage of fossil Fuels, and depend on alternative renewable and greener sources of energy such as wind Energy, solar energy, water or hydropower, Biomass, and geothermal energy.
- **Energy saving tips** – we can adopt energy Saving tips by investing in more expensive Energy-saving appliances like the compact Fluorescent light (CFL) bulbs, Air-Conditioners, refrigerators etc. Switching off Our electrical appliances when not in use.
- **Green driving tips** – The best strategy to Reduce toxic gas emissions is definitely to reduce the use of automobiles. Use public Transport, carpooling, use of electricity Powered cars or two wheelers can be an Alternative.
- **Reduce – Reuse – Recycle practices** – Reducing, reusing and recycling helps us Conserve resources and energy, and reduce Pollution and greenhouse gas emissions Produced thereby.

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- **Re-forestation** – The cleanest and most efficient remover of carbon dioxide from our atmosphere actually is nothing but green plants and trees.
- The rate at which we are cutting down our trees and forests to make way for human developments has Greatly reduced the earth's ability to remove Carbon dioxide from the atmosphere Organic farming – Soils are an important Sink for atmospheric carbon dioxide.
- Nevertheless, deforestation making way for conventional agriculture is increasingly Depleting this sink.
- Sustainable and organic Agriculture helps to counteract climate Change by restoring soil organic matter Content as well as reduce soil erosion and improve soil physical structure.
- Organic Farming uses natural fertilizers and helps maintain crop yields.

Intergovernmental Panel on Climate Change (IPCC)

- It was set up in 1988 by the World Meteorological Organization and United Nations Environment Programme
- The International Panel on Climate Change (IPCC) is a United Nations intergovernmental group tasked with expanding knowledge on human-caused climate change.
- It is the international body in charge of evaluating climate change science.
- The IPCC was created to offer policymakers with periodical evaluations of the scientific foundation of climate change.
- IPCC assessments offer a scientific foundation for governments at all levels to establish climate-related policies, and they serve as the foundation for talks at the United Nations Framework Convention on Climate Change (UNFCCC).
- The IPCC creates comprehensive Assessment Reports on the current state of scientific, technological, and socioeconomic knowledge about climate change, its consequences and future dangers, and alternatives for slowing the rate of climate change.

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- It also publishes Special Reports on issues agreed upon by its member states, as well as Methodology Reports that give guidance for greenhouse gas inventories.
- The IPCC is a globally recognised authority on climate change, and its findings are largely accepted by top climate scientists and governments.
- Its studies are crucial to the United Nations Framework Convention on Climate Change (UNFCCC), with the Fifth Assessment Report strongly influencing the historic Paris Agreement in 2015.
- The IPCC and Al Gore shared the 2007 Nobel Peace Prize for their contributions to human understanding of climate change.

IPCC - Assessment Report

- The Assessment Reports, the first of which was published in 1990, are the most in-depth assessments of the condition of the Earth's climate.
- The IPCC publishes assessment reports every few years (about every seven years).
- Hundreds of professional's pore through every piece of relevant, published scientific material to produce a shared understanding of climate change.
- The four successive assessment reports, totalling thousands of pages, were published in 1995, 2001, 2007, and 2015.
- These have served as the foundation for the worldwide response to climate change.
- Each assessment report has expanded on the work of the preceding ones over the years, providing additional evidence, information, and statistics.
- As a result, most judgments concerning climate change and its consequences today have significantly greater clarity, confidence, and a plethora of fresh information than previously.
- These discussions resulted in the Paris Agreement and, before, the Kyoto Protocol.
- The Paris Agreement was negotiated in response to the Fifth Assessment Report.
- The Assessment Reports are produced by three scientific working groups.

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- Working Group I focuses on the scientific foundations of climate change.
- Working Group II investigates potential consequences, vulnerabilities, and adaptive challenges.
- Working Group III focuses on possible climate change mitigation measures.
- The fourth and final instalment of the sixth assessment report (AR6) by the Intergovernmental Panel on Climate Change was released.
- Greenhouse Gas (GHG) emissions will lead to increasing global warming in the near term, and it's likely this will reach 1.5°C between 2030 and 2035.
- The world is currently at around 1.1°C of warming, and current climate policies are projected to increase global warming by 3.2°C by 2100.
- The IPCC has “very high confidence” that the risks and adverse impacts from climate change will escalate with increasing global warming.
- To keep within the 1.5°C limit, emissions need to be reduced by at least 43% by 2030 compared to 2019 levels and at least 60% by 2035.
- Losses and damages will disproportionately affect the poorest and most vulnerable populations, particularly those in Africa and least-developed countries, creating more poverty.
- Tracked climate finance for mitigation falls short of the levels needed to limit warming to below 2°C or to 1.5°C across all sectors and regions.
- Public and private finance flows for fossil fuels are still greater than those for climate adaptation and mitigation.
- Prioritizing equity, social justice, inclusion, and just transition processes would enable ambitious climate mitigation actions and climate-resilient development.