Climate change

The periodic modification of Earth's climate brought about due to the changes in the atmosphere as well as the interactions between the atmosphere and various other geological, chemical, biological and geographical factors within the Earth's system is called Climate change. Human actions are causing Earth to warm by increasing the amount of carbon dioxide in the atmosphere.

The main causes of climate change include:

1. Emission of greenhouse gases into the atmosphere
2. Deforestation for human settlements
3. Overutilization and exploitation of natural resources
4. Pollution caused by human activities
5. Changes in solar output which is associated with sunspot activities
6. The aerosols that reach the atmosphere after volcanic eruptions

Factors Affecting Climate Change

Natural Factors – affect the climate over a period of thousands to millions of years. Such as

1. **Continental Drift** – have formed millions of years ago when the landmass began to drift apart due to plate displacement. This impacts climate change due to the change in the landmass's physical features and position and the change in water bodies' position like the change in the follow of ocean currents and winds.
2. **Volcanism** – Volcanic eruption emits gasses and dust particles that last for a longer period causing a partial block of the Sun rays thus leading to cooling of weathers and influencing weather patterns.
3. **Changes in Earth's Orbit –** A slight change in the Earth's orbit has an impact on the sunlight's seasonal distribution reaching earth's surface across the world. There are three types of orbital variations – variations in Earth's eccentricity, variations in the tilt angle of the Earth's axis of rotation and precession of Earth's axis. These together can cause Milankovitch cycles, which have a huge impact on climate and are well-known for their connection to the glacial and interglacial periods.

Anthropogenic Factors – is mainly a human-caused increase in global surface temperature. Such as –

1. **Greenhouse Gasses** – these absorb heat radiation from the sun resulting in an increase in Global Temperature. GHGs mostly do not absorb solar radiation but absorb most of the infrared emitted by the Earth's surface. Global warming begins with the greenhouse effect, which is caused by the interaction between incoming radiation from the sun and the atmosphere of Earth.

1. **Atmospheric Aerosols –** these can scatter and absorb solar and infrared radiation. Solar radiation scatters and cools the planet whereas aerosols on absorbing solar radiation increase the temperature of the air instead of allowing the sunlight to be absorbed by the Earth's surface. Aerosols have a direct affect on climate change on absorption and reflection of solar radiation. Indirectly it can affect by modifying

clouds formation and properties. It can even be transported thousands of kilometres away through winds and circulations in the atmosphere.

2. **Shift in land-use pattern –** Most of the forests and land covers are replaced by agricultural cropping, land grazing, or for Industrial or commercial usage. The clearing of forest cover increases solar energy absorption and the amount of moisture evaporated into the atmosphere.
    - The lower the albedo (reflectivity of an object in space), the more of the Sun's radiation gets absorbed by the planet and the temperatures will rise. If the albedo is higher and the Earth is more reflective, more of the radiation is returned to space, leading to the cooling of the planet.

Potential Effects of climate change in India

- **Extreme Heat**: India is already experiencing a warming climate. Unusual and unprecedented spells of hot weather are expected to occur far more frequently and cover much larger areas. Under 4°C warming, the west coast and southern India are projected to shift to new, high-temperature climatic regimes with significant impacts on agriculture.
- **Changing Rainfall Patterns**: A decline in monsoon rainfall since the 1950s has already been observed. A 2°C rise in the world's average temperatures will make India's summer monsoon highly unpredictable. At 4°C warming, an extremely wet monsoon that currently has a chance of occurring only once in 100 years is projected to occur every 10 years by the end of the century. Dry years are expected to be drier and wet years wetter.
- **Droughts**: Evidence indicates that parts of South Asia have become drier since the 1970s with an increase in the number of droughts. Droughts have major consequences. In 1987 and 2002-2003, droughts affected more than half of India's crop area and led to a huge fall in crop production. Droughts are expected to be more frequent in some areas, especially in north-western India, Jharkhand, Orissa, and Chhattisgarh. Crop yields are expected to fall significantly because of extreme heat by the 2040s.
- **Groundwater:** Even without climate change, 15% of India's groundwater resources are overexploited. Falling water tables can be expected to reduce further on account of increasing demand for water from a growing population, more affluent lifestyles, as well as from the services sector and industry.
- **Glacier Melt**: Most Himalayan glaciers have been retreating over the past century. At 2.5°C warming, melting glaciers and the loss of snow cover over the Himalayas are expected to threaten the stability and reliability of northern India's primarily glacier-fed rivers. Alterations in the flows of the Indus, Ganges, and Brahmaputra rivers could significantly impact irrigation, affecting the amount of food that can be produced in their basins as well as the livelihoods of millions of people
- **Sea level rise:** With India close to the equator, the sub-continent would see much higher rises in sea levels than higher latitudes. Sea-level rise and storm surges would lead to saltwater intrusion in the coastal areas, impacting agriculture, degrading groundwater quality, contaminating drinking water, and possibly causing a rise in diarrhoea cases and cholera outbreaks, as the cholera bacterium survives longer in

saline water. Kolkata and Mumbai, both densely populated cities, are particularly vulnerable to the impacts of sea-level rise, tropical cyclones, and riverine flooding.

India's response to Climate Change

- **National Action Plan on Climate Change (NAPCC)**: outlines existing and future policies and programs addressing climate mitigation and adaptation. The Action Plan identifies eight core "national missions" running through to 2017: Solar Energy; Enhanced Energy Efficiency; Sustainable Habitat; Water; Sustaining the Himalayan Ecosystem; Green India; Sustainable Agriculture; and Strategic Knowledge for Climate Change. Most of these missions have strong adaptation imperatives.
- **National Clean Energy Fund:** The Government of India created the National Clean Energy Fund (NCEF) in 2010 for financing and promoting clean energy initiatives and funding research in the area of clean energy in the country. The corpus of the fund is built by levying a cess of INR 50 (subsequently increased to INR 100 in 2014) per tonne of coal produced domestically or imported.
- **Paris Agreement:** Under the Paris Agreement, India has made three commitments. India's greenhouse gas emission intensity of its GDP will be reduced by 33-35% below 2005 levels by 2030. Alongside, 40% of India's power capacity would be based on non-fossil fuel sources. At the same time, India will create an additional 'carbon sink' of 2.5 to 3 billion tonnes of Co2 equivalent through additional forest and tree cover by 2030.
- **International Solar Alliance:** ISA was launched at the United Nations Climate Change Conference in Paris on 30 November 2015 by India and France, in the presence of Mr. Ban Ki Moon, former Secretary-General of the United Nations.
- **Bharat Stage (BS) Emission Norms:** Emissions from vehicles are one of the top contributors to air pollution, which led the government at the time to introduce the BS 2000 (Bharat Stage 1) vehicle emission norms from April 2000, followed by BS-II in 2005. BS-III was implemented nationwide in 2010.

What is Greenhouse Gas?

A greenhouse gas is a gas that absorbs and emits infrared radiation. They absorb infrared energy (heat energy) emitted from the earth's surface and reradiates it back to the earth's surface. The greenhouse gases trap heat in the earth's atmosphere and warm the planet.

What are Greenhouse Gases?

- In simple terms, gases that trap heat in the earth's atmosphere are known as Greenhouse Gases, abbreviated as GHGs.
- They contribute to the **Greenhouse Effect**, which is the resultant heating effect.

Greenhouse Effect Explanation

- A greenhouse or a glasshouse is a closed glass structure in which plants are grown in regulated climatic conditions.
- In such a structure, the solar radiation passes through the glass and is absorbed by the floor, earth, and other contents inside.
- They, in turn, become warmer and reradiates the energy as infrared (heat) radiation which is of a longer wavelength.
- This radiation cannot escape from the glass since glass cannot transmit infrared radiation. Thus, the temperature inside the greenhouse increases.
- This is the Greenhouse Effect.

Greenhouse Gases Examples

The Primary GHGs are:

1. Water Vapour
2. Carbon dioxide
3. Methane
4. Nitrous oxide
5. Ozone

Other GHGs are carbon monoxide, fluorinated gases, chlorofluorocarbons (CFCs), black carbon (soot), and brown carbon.

Among the greenhouse gases, only water vapour can absorb both incoming (UV) and outgoing (infrared) radiation.

Global Warming Definition

"Global warming is a gradual increase in the earth's temperature generally due to the greenhouse effect caused by increased levels of carbon dioxide, CFCs, and other pollutants."

What is Global Warming?

Global warming is the phenomenon of a gradual increase in the temperature near the earth's surface. This phenomenon has been observed over the past one or two centuries. This change has disturbed the climatic pattern of the earth. However, the concept of global warming is quite controversial but the scientists have provided relevant data in support of the fact that the temperature of the earth is rising constantly.

There are several causes of global warming, which have a negative effect on humans, plants and animals. These causes may be natural or might be the outcome of human activities. In order to curb the issues, it is very important to understand the negative impacts of global warming.

Causes of Global Warming

Following are the major causes of global warming:

Man-made Causes of Global Warming

Deforestation

Plants are the main source of oxygen. They take in carbon dioxide and release oxygen thereby maintaining environmental balance. Forests are being depleted for many domestic and commercial purposes. This has led to an environmental imbalance, thereby giving rise to global warming.

Use of Vehicles

The use of vehicles, even for a very short distance results in various gaseous emissions. Vehicles burn fossil fuels which emit a large amount of carbon dioxide and other toxins into the atmosphere resulting in a temperature increase.

Chlorofluorocarbon

With the excessive use of air conditioners and refrigerators, humans have been adding CFCs into the environment which affects the atmospheric ozone layer. The ozone layer protects the earth surface from the harmful ultraviolet rays emitted by the sun. The CFCs have led to ozone layer depletion making way for the ultraviolet rays, thereby increasing the temperature of the earth.

Industrial Development

With the advent of industrialization, the temperature of the earth has been increasing rapidly. The harmful emissions from the factories add to the increasing temperature of the earth.

In 2013, the Intergovernmental Panel for Climate Change reported that the increase in the global temperature between 1880 and 2012 has been 0.9 degrees Celsius. The increase is 1.1 degrees Celsius when compared to the pre-industrial mean temperature.

Agriculture

Various farming activities produce carbon dioxide and methane gas. These add to the greenhouse gases in the atmosphere and increase the temperature of the earth.

Overpopulation

An increase in population means more people breathing. This leads to an increase in the level of carbon dioxide, the primary gas causing global warming, in the atmosphere.

Natural Causes of Global Warming

Volcanoes

Volcanoes are one of the largest natural contributors to global warming. The ash and smoke emitted during volcanic eruptions goes out into the atmosphere and affects the climate.

Water Vapour

Water vapour is a kind of greenhouse gas. Due to the increase in the earth's temperature, more water gets evaporated from the water bodies and stays in the atmosphere adding to global warming.

Melting Permafrost

Permafrost is frozen soil that has environmental gases trapped in it for several years and is present below Earth's surface. It is present in glaciers. As the permafrost melts, it releases the gases back into the atmosphere, increasing Earth's temperature.

Forest Blazes

Forest blazes or forest fires emit a large amount of carbon-containing smoke. These gases are released into the atmosphere and increase the earth's temperature resulting in global warming.

Effects of Global Warming

Following are the major effects of global warming:

Rise in Temperature

Global warming has led to an incredible increase in earth's temperature. Since 1880, the earth's temperature has increased by ~1 degrees. This has resulted in an increase in the melting of glaciers, which have led to an increase in the sea level. This could have devastating effects on coastal regions.

Threats to the Ecosystem

Global warming has affected the coral reefs that can lead to the loss of plant and animal lives. Increase in global temperatures has made the fragility of coral reefs even worse.

Climate Change

Global warming has led to a change in climatic conditions. There are droughts at some places and floods at some. This climatic imbalance is the result of global warming.

Spread of Diseases

Global warming leads to a change in the patterns of heat and humidity. This has led to the movement of mosquitoes that carry and spread diseases.

High Mortality Rates

Due to an increase in floods, tsunamis and other natural calamities, the average death toll usually increases. Also, such events can bring about the spread of diseases that can hamper human life.

Loss of Natural Habitat

A global shift in the climate leads to the loss of habitats of several plants and animals. In this case, the animals need to migrate from their natural habitat and many of them even become extinct. This is yet another major impact of global warming on biodiversity.

Global goals

- The goal envisaged in the Paris Agreement is to limit global warming to well below 2 degree Celsius, preferably to 1.5 degrees Celsius, compared to pre-industrial levels.
- To achieve this goal, greenhouse gas emitting countries have to make commitments to cut their climate pollution.
- The countries, which are part of this agreement, communicate their actions to reduce GHG emissions in the Nationally Determined Contributions (NDCs) in order to reach the goals of the Paris Agreement.