

Environment Class 10

7th March, 2024 at 9:00 AM

IMPACT OF CLOUDS (09:09 AM)

- Clouds can have both warming and cooling effects on the climate.
- Climate change can lead to changes in the **coverage, altitude and reflectivity** of the cloud.
- These changes can either **amplify or dampen** the original change.

IMPACT OF AEROSOLS

- Aerosols are microscopic solid or liquid particles that are so small ^{that} they **remain suspended** in the air from days to weeks.
- The effect of aerosols varies, most of the aerosols can have a cooling effect as they reflect more sunlight.
- But some aerosols such as **black carbon (soot)**, ^{emerging from burning of coal, diesel, petrol can have} **warming effect.**

RADIATIVE FORCING

- It is defined as **changing the earth's heat balance due to some external change.**
- It is measured in **watts/m²**.
- E.g. The increased amount of **CO₂/CH₄** **has positive radiative forcing** which means more heat is incoming than outgoing. ^{Such as}
- Some factors ^{are} ^{have} negative radiative forcing ^{are} aerosols in the atmosphere.

CAUSES OF CLIMATE CHANGE (09:31 AM)

- In past also climate change has occurred.
- Many natural processes can contribute to climate change.
- **i. Variation in solar activity:** The measurements shown from the last few decades do not point to any net increase in solar activities.
- **ii. Milankovitch Cycle:** Earth's orbit and its axis of rotation are not fixed. This cycle includes:
 - a. The shape of the earth's orbit is determined by eccentricity. This changes in about 100,000-400,000 years.
 - b. The axial tilt changes from **21.5 degrees to 24.5 degrees**. in about 40,000 years.
 - c. ^{These cycles cannot explain the rapid warming.} **The axis of rotation in itself precesses.**
- **iii. Volcanic activity:** They **can release large CO₂, but they also release SO₂**, aerosols which can contribute to global cooling.
- This is why Scientists can say with high certainty that the current increase in temperature is mostly anthropogenic.
- **Global Warming Potential**
- GWP of a gas refers to the **total contribution to global warming** resulting from the emission of **one unit of that gas relative to one unit of reference gas** which is taken as CO₂ for a duration of time. ^{assigned}
- **The GWP of carbon dioxide is defined as 1.**
- **Baseline Year:**
- Researchers calculate the average increase in temperature based on a baseline year which is taken as 1850-1900. ^(because in 2nd IR GHG's emission was higher)
- This represents **pre-industrial temperature**.
- Compared to pre-industrial temperature the average temperature increase has been about **1.2 Degrees Celsius.**

2. Transportation :- Combustion of fossil fuels such as petrol and diesel in combustion engine in different modes of transportation.

1. Electricity :-

- **Key Greenhouse Gases:**

- **CO₂ Sources:** (GWP = 1)

- Burning of Coal, Natural Gas, and Diesel.

through

- 3. Industry: Many industrial processes emit CO₂ for fossil fuel consumption. E.g. Cement, Iron and Steel industry, etc.

- **Mitigation:**

- Renewable Energy Sources
- Afforestation (So that carbon sink can be increased.)
- Decarbonisation of the transportation sector. (Using EVs, hydrogen combustion engines, fuel cells)
- Behavioural Changes: Use of Public Transport
- Energy Efficient equipment Ex: LED bulbs.
- Carbon Tax Ex: Coal Cess

-> Carbon Capture Utilization and Storage (CCUS).

-> Carbon Market.

- **Carbon offset**

- **Carbon Capture, Utilization, and Storage (CCUS)**

- The atmospheric CO₂ concentration has increased from 280 parts per million (pre-industrial level) to 421 PPM in 2022.

- **Methane (CH₄) Sources** (GWP = 25)

ppb (micro gm/L)

- The average concentration of methane has increased from 720 ppm to 1900 ppm.

ppb

- It is emitted by natural sources also such as natural wetlands, termites, volcanoes, and wildfires.

- About 60 percent of emissions are anthropogenic.

- Out of total anthropogenic emissions, 61 percent is because of agriculture and livestock farming, 20 percent is because of waste and the remaining is mostly because of the energy sector.

1. Agriculture:-

- a. Certain types of crops such as rice, are a large source of methane emission.

b. Enteric Fermentation

- **Domestic livestock** produce methane as part of the digestive process. These are called ruminant animals.

- They have a large stomach within which microbial fermentation in anaerobic conditions releases methane.

- The animal manure stored in holding tanks also released methane.

2. Waste:-

- Methane is generated in landfills as waste decomposes. and it also generated in industrial waste water treatment.

- 3. **Energy and Industry:** These are a major source and it is emitted during production, processing, storage and transmission of natural gas. (because of leakages)

- **Coal mining** is another source of methane emission

- **Mitigation (10:38 AM)**

- Change in cropping pattern. (can focus more on millet)
- Modification to animal feeding practices.
- Upgrading the equipment to prevent leakages from the energy sector and industrial emissions.
- Better manure management and waste management practices.
- Methane has a relatively smaller life and within a decade or two it oxidizes to CO₂.

atmospheric

Nitrous Oxide

NITROGEN DIOXIDE (11:03 AM) (N₂O and GWP = 298)

- The average concentration of N₂O has increased from 270 ppm to 330 ppm.
- It can be released naturally as part of the nitrogen cycle. ppb ppb
- About 50 percent is anthropogenic and major sources are:
- **Use of Synthetic and Organic fertilisers**
- Burning of agricultural residue.
- A byproduct of nitric acid and adipic acid production.
- Nitric acid is used to make synthetic fertilisers and adipic acid is used to make fibres such as nylon.
- Fuel combustion can release nitrous oxide.
- Treatment of domestic wastewater.
- **Mitigation**
- Efficient use of Nitrogen-based fertilisers.
- Technological upgrades to prevent leakages from the industry.
- Selective Catalytic Reduction in Vehicles to reduce nitrogen oxide into nitrogen.
- N₂O has a lifetime of more than 100 years.

GWP: N₂O > CH₄ > CO₂

Impact on GW: CO₂ > CH₄ > N₂O

because of concentration of CO₂ is high in atmosphere.

Flourinated CHLORINATED GASES (11:16 AM) (These are very much harmful and totally anthropogenic)

- a. CFCs - Chlorofluorocarbons
- b. HCFC - Hydrochlorofluorocarbons
- c. HFCs - Hydrofluorocarbons
- d. Sulphur hexafluoride (SF₆)
- e. Nitrogen trifluoride (NF₃)
- **HFCs - Hydrofluorocarbons:** (We used HCFC in place of CFC but this HCFC is also ozone depleting so we use HFC) i
- GWP can be upto 14800 and atmospheric life could be 270 years. They are used as refrigerants.
- They are used as aerosol propellant, solvents, and fire retardants. propellants, Foam,
- **Perfluorocarbons (PF₆)** f. Perfluoro Carbon (PF₆)
- They are produced as a byproduct in aluminium production and they are also used in semiconductors. -> It can have GWP upto 12,200.
- It has an atmospheric life of up to 50,000 years.
- **Sulphur hexafluoride (SF₆) (Imp)**
- GWP of 22800 and atmospheric lifetime of 3200 years.
- It is used in magnesium manufacturing, semiconductor manufacturing, insulating gas, and circuit breakers. processing
- **Nitrogen trifluoride (NF₃)**
- GWP of 17200, and atmospheric life of 740 years.
- This is used in semiconductor manufacturing.
- All of these are 100 percent anthropogenic in nature.
- **Mitigation:**
- Recycling of already existing gases.
- Destruction of the gases
- Finding suitable alternatives
- In terms of emissions by country, china is the largest emitter followed by the US., EU, India, Russia and Japan.
- In terms of per capita emission India's contribution is much less. than global average.

These countries contribute to 65% of global emission.

Impact in Cryosphere :- (Cryosphere means frozen part of Earth)

IMPACT OF CLIMATE CHANGE (11:45 AM)

- The **cryosphere** comprises parts of the earth which is **frozen**. E.g. **Snow, Ice Glaciers, Ice sheets, Permafrost**.
- The cryosphere is affected in many ways due to climate change.
- a. **Melting of Ice and Snow :-** glaciers, ice caps
- Because of accelerated melting, we are witnessing sea level rise and altered water supply among others. -> Ice caps are part of ice which is on surface but somehow floating in ocean.
- b. **Reduced Sea Ice:** Both the extent and thickness of the Arctic Sea have decreased ~~river~~ recent decades. -> Sea ice plays a crucial role in regulating planet's temp. because of high albedo. ~~over~~ compared to rest of the planets, this is called Arctic Amplification.
- Regulating planet's temperature because of high albedo.
- Because of Ice-albedo feedback, the Arctic is witnessing accelerated warming.
- **Permafrost Thawing:**
- Rising temperatures can cause permafrost to thaw **releasing CO2, Methane** which can further accelerate global warming.
- The impact of global warming on the Arctic and the Antarctic is not the same. ~~disintegrating~~
- The Arctic has witnessed rapid warming and the western Antarctica ice sheet is ~~disintegrating~~ because of global warming.
- Eastern Antarctica has shown resilience, the **difference in the impact on the Arctic and the Antarctic is because of the following:**
- - The Arctic is an ocean surrounded by the continents.
- - The Antarctic is a continent surrounded by the Southern Ocean.
- - Thus the **differential heating of land and water** plays an important role.
- - The Antarctica central plateau is at a high altitude which means colder temperature.
- While arctic sea level nature makes it more susceptible to warming.
- The **antarctic circum-polar current**, a cold current, flows around Antarctica and somewhat **isolates it from other ocean basins** which limits the exchange of heat.
- The **polar vortex** at Antarctica is much stronger.

The topic for the next class: Impact on the Himalayas, Steps to tackle climate change