

## Lecture 7

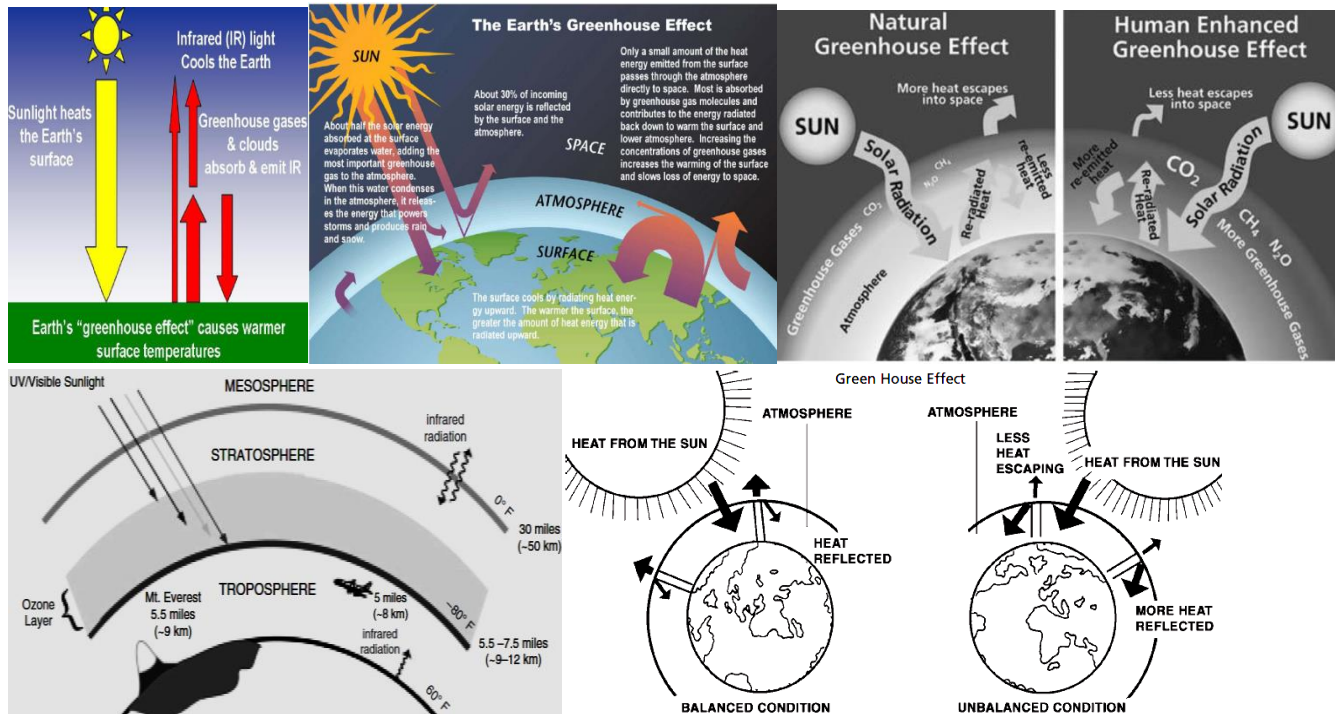
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### Global Warming

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. This change has disturbed the climatic pattern of the earth.



Climate change has occurred for as long as the earth has existed. It happens anytime earth's climate patterns change and remain in place for a measurable amount of time. This has notably manifested itself in natural cycles of cooling and warming. Before human causes started to shift the global climate, five main factors interacted with one another as climate changes occurred. These five factors include:

1. Atmosphere (air)
2. Biosphere (living things)
3. Cryosphere (ice and permafrost)
4. Hydrosphere (water)
5. Lithosphere (earth's crust and upper mantle)

The pH value of the ocean has decreased by 0.1 pH units, which is about a 30 percent increase in acidity. This change is enough to affect many marine organisms. For example, acidification stunts shellfish shell formation and can even cause shells to dissolve.

#### Green House Gases

By their percentage contribution to the greenhouse effect on Earth four major gases are:

**Water vapors 36-70%- Carbon dioxide 9-26%- Methane 4-9%- Ozone-3-7%- Others (SO<sub>x</sub>, NO<sub>x</sub>, CFCs)**

About high percent of the Earth's **natural greenhouse** effect is due to water vapor and clouds. Most of the rest is due to carbon dioxide, methane, and a few other minor gases. While the remaining gases in the atmosphere (e.g. nitrogen, oxygen) also absorb and emit a small amount of infrared radiation, their radiative effect on temperature is so weak that they can be neglected.

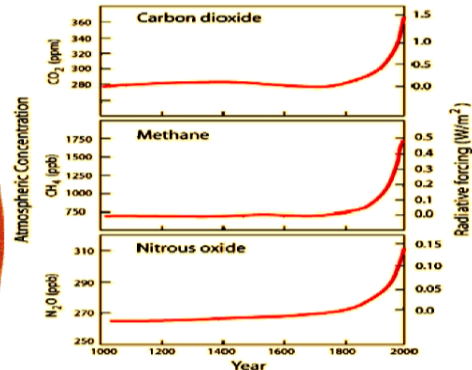
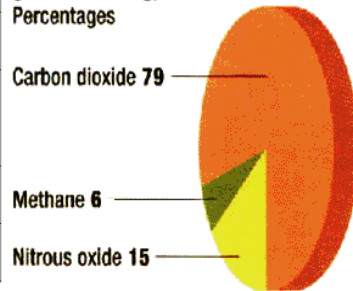
Strengthening of the greenhouse effect through human activities is known as the **enhanced greenhouse effect**. This increase in radiative forcing from human activity is attributable mainly to increased atmospheric carbon dioxide level.

- Temperature of the earth increased in last few decades called **global warming**.
- Widening of Arctic Ozone hole and **depletion of ozone layer**.
- Oceans are warm leading to sea level rise in different localities.
- Glaciers and snow covers are melting down.
- Arctic ice cover is shrinking in depth and extent.
- Seasonal changes are observed.

- Climatic condition is altered.
- Extreme and erratic weather conditions leading to flood, drought, famine and various diseases.
- More intensive and longer droughts are observed
- Change in vegetation pattern
- Threatened ecosystem, communities and livelihood,
- Loss of land due to inundation and erosion increased flooding and salt water intrusion.
- Effect on coastal agriculture, fisheries, aquaculture, and tourism
- Social economic impacts of climate changes on human civilization

GHG's	Sources
CO <sub>2</sub>	Burning of solid waste, wood, fossil fuel, deforestation
CH <sub>4</sub>	Organic waste deposition,(land fills and livestock farming)Production and transport of fossil fuel.
CFC's	Refrigeration, Solvents, foams, general propellants
NO <sub>x</sub> & SO <sub>x</sub>	Agricultural and industrial processes.

**Contribution of greenhouse gases to global warming, 1980-90 Percentages**



As the planet gets hit with the sun's rays, some of the energy is absorbed, and the rest of that energy and heat gets reflected into space. Greenhouse gases in the atmosphere trap the reflected energy, redirecting it back down to the earth and eventually contributing to global warming. Various gases play this role, including: **Water vapor, CO<sub>2</sub>, Methane, Nitrous oxide, Chlorofluorocarbons (CFCs),**

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 vapor 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.

The main greenhouse gases, namely: **Carbon dioxide (CO<sub>2</sub>); Methane (CH<sub>4</sub>); Nitrous oxide (N<sub>2</sub>O); Hydrofluorocarbons (HFCs); Perfluorocarbons (PFCs); and Sulphur hexafluoride (SF<sub>6</sub>).** The impact of any GHG is based on the magnitude of the rise in its concentration, its duration in the atmosphere and the wavelength of radiation that is absorbed.

**1. Carbon dioxide** is the GHG which is present in the largest concentration in the atmosphere. Its emission chiefly comes from fossil fuel combustion. It is showing a rise of about 0.5% per annum.

**2. Methane (CH<sub>4</sub>)** - The chief source are sulphur springs, volcanic eruptions, organic waste deposition and decaying vegetation, animal matter, (aquatic habitats) combustion processes as stove, furnaces, open fire (forest), burning coal mines, power plants, production and transportation of fossil fuel, etc.

**3. Chlorofluorocarbons (CFCs)** are produced due to anthropogenic activity. Ozone is present in the stratosphere where ultraviolet (UV) radiations convert oxygen into ozone. Hence, the UV rays do not reach the Earth's surface. The CFCs which goes into the stratosphere destroys the ozone, which is evidently seen over Antarctica. The reduction of ozone concentration in the stratosphere is known as the ozone hole. This permits the UV rays to pass through the troposphere.

**4. Nitrous oxide** is naturally produced by oceans and rainforests. Man-made sources of nitrous oxide include nylon and nitric acid production, the use of fertilizers in agriculture, cars with catalytic converters and the burning of organic matter.

**4. Hydrofluorocarbons (HFCs) 5. Perfluorocarbons (PFCs): 6. Sulphur hexafluoride (SF<sub>6</sub>):**

### Impacts of Global Warming

## 1-Extreme Weather

Changes to weather are perhaps the most noticeable effect of climate change for the average person. One reason for this is the financial impact severe weather events can have. So far in the U.S. during 2019, there have been six climate disasters, most costing more than \$1 billion. Extreme weather influenced by climate change includes: Stronger storms & hurricanes – Heatwaves – Wildfires - More flooding-Heavier droughts.

## 2-Negative Impact in Ecosystems

Ecosystems are interconnected webs of living organisms that help support all kinds of plant and biological life. Climate change is already changing seasonal weather patterns and disrupting food distribution for plants and animals throughout the world, potentially causing mass extinction events. Some studies estimate that nearly 30% of plant and animal species are at risk of extinction if global temperatures continue to rise.

1. **Rising Sea level:** Flooding of fresh water marshlands, low-lying cities, and islands with marine water is one of the major effects of global warming.

2. **Changes in rainfall patterns:** In some areas, droughts and fires happen, whereas in other areas, flooding takes place. This all is due to changes in rainfall pattern.

3. **Melting of the ice peaks:** Due to melting of the ice peaks, there is loss of habitat near the poles. Now the polar bears are considered to be greatly endangered by the shortening of their feeding season because of declining ice packs.

4. **Melting glaciers:** There is a significant melting of old glaciers.

5. **Spread of disease:** There is spread of diseases like malaria due to migration to newer and currently warmer regions.

6. **Thinning of Coral Reefs** due to warming seas as well as acidification because of carbonic acid formation: Almost one-third of coral reefs are now severely damaged by warming seas.

7. **Loss of Plankton** owing to warming seas: The large (900 miles long) Aleutian island ecosystems consisting of whales, sea lions, sea urchins, kelp beds, fish, and other aquatic animals, has now reduced due to loss of plankton.

8.**Reduced food security:**One of the most striking impacts of rising temperatures is felt in global agriculture, although these impacts are felt very differently in the largely temperate developed world and in the more tropical developing world.

9.**Downpours and storms:**Torrential downpours and devastating storms will increase large-scale damage to fields, homes, businesses, transportation and power systems and industry in countries without the financial or human capital resources to respond.

10.**Heatwaves and droughts:**Heatwaves and droughts will increase pressure on already fragile power, healthcare, water and sewage systems, as well as reducing countries' ability to feed themselves or export agricultural products.Heat will also become an increasingly important killer, especially of the very young and the old.

## 11. Health

There are many ways in which climate change could impact people's health. Depending on age, location, and economic status, climate change is already affecting the health of many and has the potential to impact millions more. According to the Center for Disease Control and Prevention, climate change-related health risks may **include:** Heat-related illness - Injuries and fatalities from severe weather - Asthma & cardiovascular disease from air pollution - Respiratory problems from increased allergens - Diseases from poor water quality -Water & food supply insecurities.

TheDiseases, like pests, develop more rapidly in the heat and so do their insect vectors. Moreover, with climate change, the range of critical vectors – mosquitos, for example, vectors for dengue, encephalitis, malaria, West Nile and Zika – all expand putting larger and larger populations at risk.

Look first at the primary sources of the GHGs that cause global warming: Power generation (25%); industry (21%); transportation (14%) and buildings (6%).

**Table: Greenhouse gas, Sources, Global Warming Potential and Proportion of total effect**

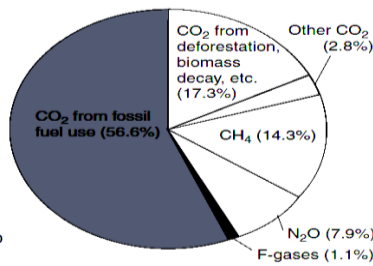
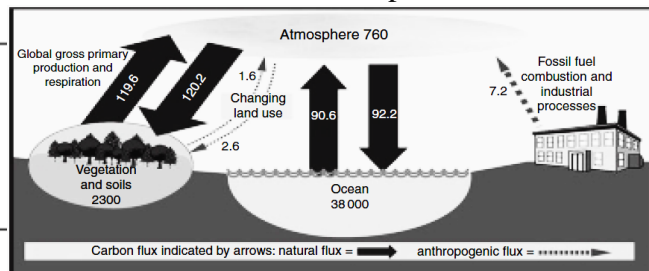
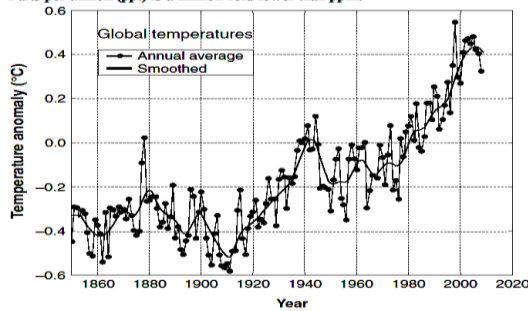
Greenhouse gas	Concentration change, 1800s- 2018	Anthropogenic sources	100-yr GWP*	Proportion of total effect apart from water vapor (approximate)
carbon dioxide	280 - 408 ppm	fossil fuel burning, deforestation, Industries transportation	1	66%
methane	0.75 - 1.87 ppm	agriculture, fuel leakage	25	17%
halocarbons	0 - 0.7 ppb	refrigerants	1100-11,000	11%
nitrous oxide	270 - 331 ppb	agriculture, combustion	300	6%
ozone	15? - 20-30 ppb	urban pollution		

\* World Meteorological Organization, WMO Greenhouse Gas Bulletin No. 15 (25 November 2019) GWP (Global Warming Potential)

- The average global temperature for 2015-2019 is on track to be the warmest of any equivalent period on record. It is currently estimated to be 1.1 °C (±0.1 °C) above pre-industrial (1850-1900) times.
- CO<sub>2</sub> emissions from fossil fuel use continue to grow by over 1% annually and 2% in 2018, having reached a new high of 53.5 Gt/yr CO<sub>2</sub> equivalent in 2017.
- The ocean absorbs nearly 25% of the annual emissions of anthropogenic CO<sub>2</sub> thereby helping to alleviate the impacts of climate change on the planet. The absorbed CO<sub>2</sub> reacts with seawater and increases the acidity of the ocean.
- Implementing current unconditional nationally-determined contributions (NDC) to reducing CO<sub>2</sub> emissions under the Paris Agreement would lead to a global mean temperature rise between 2.9 °C and 3.4 °C by 2100 relative to pre-industrial levels, and continuing thereafter..
- Meeting the Paris Agreement requires immediate and all-inclusive action encompassing deep decarbonization complemented by ambitious policy measures, protection and enhancement of carbon sinks and biodiversity, and effort to remove CO<sub>2</sub> from the atmosphere.

	Pre-Industrial Revolution	Current level	Warming potential CO <sub>2</sub> = 1	Lifetime in atmosphere
Carbon dioxide (CO <sub>2</sub> )	280 ppm	387 ppm	1	~100 years
Methane (CH <sub>4</sub> )	700 ppb	1791 ppb	25	12 years
Nitrous oxide (N <sub>2</sub> O)	270 ppb	321 ppb	300	114 years
Ozone (O <sub>3</sub> )	25 ppb	31 ppb	-	hours/days
The gases below are examples of greenhouse gases found in the atmosphere in trace amounts				
CFC-12	Zero	539 ppt	10 900	100 years
Halon 1211	Zero	4.39 ppt	1890	16 years
Sulfur hexafluoride (SF <sub>6</sub> )	Zero	6.2 ppt	22 800	3200 years

Note: Parts per billion (ppb) is a thousand-fold lower concentration than parts per million (ppm). Parts per trillion (ppt) is a million-fold lower than ppm.



### The Battle Climate Change

Below are some practical ways for will do as individual that you can battle climate change, including:

- # Use Renewable Energy Certificate for your home power needs
- # Make your home energy efficient    # Application recycle on all field of life
- # Buy carbon offsets                    # Reduce fossil fuels using for heating and cooking
- # Adopt a plant-based diet            # Encourage use electrical car and public transportations
- # Reduce food waste                    # Stop deforestation

### References: Internet + Books