

## GLOBAL WARMING AND CLIMATE CHANGE

Earth's environment has undergone significant changes due to the increasing population and impact of its activities on natural resources. One of the most significant changes brought about by human activities is an increase in the concentration of  $\text{CO}_2$  and other green house gases in the lower layers (troposphere) and ozone depletion in the uppermost layer (stratosphere) of atmosphere. The two main causes of global warming and climate change are, carbon emissions and ozone depleting substances.

Climate change represents a change in the long term weather patterns. Climate change is not a change of weather in a particular day, it is the cumulative change of long term weather patterns. Climate change is usually measured in major shift in temperature, rainfall, snow and wind patterns lasting for decades or more. Human activities are creating climate change by burning large amounts of fossil fuels and deforestation. Burning of fossil fuel increases the concentration of  $\text{CO}_2$  and other green house gases which can not be sinksed or stored due to the deforestation. As the forests works as carbon sinks therefore carbon is released to atmosphere which contributes to global warming.

Global warming is an average increase in the temperature of the atmosphere near the earth's surface and in the troposphere which can contribute to changes in the

global climate pattern. The temperature increase over the last 70 years has been due to the increase in the green house gas concentration like water vapour,  $\text{CO}_2$ , methane, ozone etc. Green house gases are those gases that contribute to the green house effect.

### GREEN HOUSE EFFECT

The green house effect is a naturally occurring phenomenon that blankets the earth's lower atmosphere and warms it, maintaining the temperature suitable for living things to survive. In absence of naturally occurring green house effect, the average temperature of the earth surface would be  $-19^{\circ}\text{C}$  and the earth would be a frozen lifeless planet.

**MECHANISM** → → The sun emits energy that is transmitted to earth.

→ The energy is emitted in high energy short wavelengths that penetrate the earth's atmosphere.

→ About 30% of sun's energy is reflected back into space by atmosphere, clouds and the surface of the earth.

→ The rest of the sun's energy is absorbed into the earth's system.

→ The earth re-emits energy back into the atmosphere in the form of infrared radiation.

at the wave lengths longer than the incoming solar energy

- Green house gases in the atmosphere absorb much of the longwave energy (infrared) which prevent it from escaping from the earth's system.
- The green house gases re-emits this energy in all directions, warming the earth's surface and lower atmosphere.
- The atmospheric concentration of green house gases has increased largely due to human activities.
- This increase has amplified the natural green house effect by trapping more energy emitted by earth and the temperature of earth is increasing at alarming rate which causes global warming and climate change occurs.

### GREEN HOUSE GASES

#### WATER VAPOUR

Water vapour is the biggest overall contributor to the green house effect. CO<sub>2</sub> and other greenhouse gases is increasing the amount of water vapour by boosting the rate of evaporation.

#### CO<sub>2</sub>

CO<sub>2</sub> is the primary green house gas emitted

through human activities. Human activities are altering the carbon cycle both by adding more  $\text{CO}_2$  to the atmosphere and by reducing the ability of natural sinks, like forests, to remove  $\text{CO}_2$  from the atmosphere.

### METHANE

- wetlands are the largest source, emitting  $\text{CH}_4$  from bacteria (anaerobic) that decompose organic matter.
- other natural sources are termites, oceans, sediments, volcanoes and wildfires.
- Human induced sources are Agriculture, livestock industries etc.

### NITROUS OXIDE

- Natural emissions of  $\text{N}_2\text{O}$  are mainly from bacteria breaking down nitrogen in soils and oceans.
- Human induced sources are, fertilizers, livestock manure and urine, transportation, during the production of nitric acid used to make synthetic commercial fertilizers.

### FLUORINATED GASES

- Fluorinated gases have very high global warming potential (GWP) relative to other greenhouse gases.

- They are emitted through a variety of industrial processes such as aluminium and semiconductor manufacturing, substitution for ozone depleting substances etc.
- There are three main categories of fluorinated gases:-
  - i) Hydrofluorocarbons (HFCs) - They are the alternative of CFCs and HCFCs because they do not deplete ozone.
  - ii) Perfluorocarbons (PFCs) - long atmospheric life times and high GWP.
  - iii) sulfur hexafluoride (SF<sub>6</sub>) - It is used in magnesium processing and semiconductor manufacturing. Also used in electrical transmission components including circuit breakers. It is the tracer gas for leak detection.

### BLACK CARBON

- Black carbon is a solid particle or aerosol and is commonly known as soot.
- Produced from incomplete combustion.
- BC warms the earth by absorbing heat in the atmosphere and by reducing albedo (the ability to reduce sunlight) when deposited on snow and ice.
- It darkens snow packs and glaciers and leads to melting of ice and snow. Current example is Hindu Kush-Himalayan glaciers.
- Project surya has been launched to reduce BC.

## BROWN CARBON

- Biomass burning is the major source.
- It is generally referred for greenhouse gas and black carbon for particles resulting from impure combustion, such as shoot and dust.

## GLOBAL WARMING POTENTIAL (GWP)

Global warming potential describes the impact of each gas on global warming.

### GWP AND LIFE TIME OF GREEN HOUSE GASES

S.NO	GAS	GWP (100 yrs)	LIFETIME (Year)
1.	Carbon dioxide	1	100
2.	Methane	21	12
3.	Nitrous oxide	310	120
4.	Hydrofluorocarbons (HFCs)	140-11,700	1-270
5.	Perfluorocarbons (PFCs)	6,500-9,200	800-50,000
6.	Sulfur hexafluoride (SF <sub>6</sub> )	23,900	3,200

## EFFECTS OF GLOBAL WARMING AND CLIMATE CHANGE

According to UNEP the earth's temperature will rise by  $1.4^{\circ}\text{C}$  to  $5.8^{\circ}\text{C}$  upto 2100. It will effect the man and flora and fauna and the earth's climate in a very unpredictable way.

### → RISE IN ATMOSPHERIC TEMPERATURE

Green house effects has resulted into global warming. In global context even a few degree rise in temperature is deadly. An average temperature rise of only  $3^{\circ}\text{C}$  would cause  $10^{\circ}\text{C}$  rise in temperature at high altitude. For ex, temperature at nine stations north to the arctic circle has risen by  $90\text{F}$ , Average water temperature of Toolik Lake of Alaska has increased by  $3^{\circ}\text{C}$  etc.

- Development of heat waves
- Increase in suffering from disease.
- Melting of polar ice
- Rising sea level
- Increased rain fall
- Adverse effect on crop yield
- Stretching of desert
- Declining of PH of oceans
- Impact on ozone layer
- Lengthening of day
- Ozone hole at arctic is expected.

## RECEDING GLACIERS, A SYMPTOM OF GLOBAL CLIMATE

### GLOBAL CLIMATE CHANGE

About 150 years there were 147 glaciers in Glacier National park, but today only 37 glaciers remain. Scientists predict that they are likely to melt by the year 2030. Similarly, glacier all across the Himalayas and Alps are retreating and disappearing, every year. There are almost 160,000 glaciers found in polar regions and high mountain. Therefore researchers are using satellite remote sensors to set routinely survey our world's glaciers.

### IMPACT OF GLACIAL RETREAT

- The retreat of glaciers in the Andes and the Himalayas will have a potential effect on water supplies.
- These glaciers provide critical water supplies to dry countries such as Mongolia, western China, Pakistan and Afghanistan. The loss of these glaciers would have a tremendous impact on the ecosystem of the region.
- Climate change may cause variations in temperature and snow fall which would cause changes in mass balance of glacier.

## RISE IN SEA LEVEL

Currently, sea level is rising at  $1/10$  inches each year. Water expands when heated therefore sea level can continue to rise for many centuries. Water melted from glaciers can also add to the sea level rising. The impact of rising sea level can include flooding of cities, displacement of people and loss of coastal ecosystems.

If sea level rises 12 inches than 17% - 43% of coastal wetlands in the United States could be eliminated.

- If sea level rises 24 inches the United States could lose 10,000 square miles of dry land.
- Many of our cities face a severe risk of flooding. Thirteen out of fifteen of the world's largest cities in the world are on coastal plains.
- In California, parts of San Jose and Long Beach are three feet below the sea level today.
- New Orleans is about eight feet below the sea level.

## INFECTIOUS DISEASE SPREAD

Cold weather reduces the spread of infectious diseases by killing infectious organisms and their carriers. Global warming can increase the spread of disease by giving the agents a favorable condition.

## EVENTS IN GLOBAL WARMING

Combustion of fossil fuels due to  
human activities

↓  
Increase of green house gases

↓  
Global warming

↓  
Climate change

↓  
Melting of glaciers

↓  
Rise in sea level

↓  
Submergence of low-lying coastal land

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Large scale destruction of ecosystems  
and Extinction of species.