

Global warming:-

- Global warming is the term to describe the gradually rising temperature all over the world as a result of the creation of gases that trapped energy; it included green house gases (carbon dioxide, methane and nitrous oxide) which is mostly caused by humans and is life threatening.
- According to IPCC, the Average global temperature could increase between 1.4 and 5.8°C by the year 2100.
- As per IPCC, 1.2°C temperature has been increased in between 1850-2023.

Background of global warming:-

- Creation of gases such as carbon dioxide and methane is the main cause of global warming.
- Since the pre-industrial era (in the late 18th century), human have used more energy, mainly from fossil fuel sources such as coal, oil, or gas, which released into atmosphere an enormous amount of green house gases.
- Industrial and agricultural revolutions have contributed tremendously towards social, economic, political, scientific and cultural development of world, but owing to these revolutions, the human activities/interventions increased within the natural setting of the environment which aggravated the risks of global warming and many other environmental ^{problems}.

Experimentally
verified by John Tyndall
in 1861 -

Causes and Factors of Global warming :-

1. GHEs :- ~~major cause of global warming.~~ ↑
= First discovered by Joseph Fourier in 1827.

• The greenhouse effect is mostly caused by the interaction of Sun's energy with greenhouse gases such as Carbon dioxide, CH_4 , N_2O , and fluorinated gases in the Earth's atmosphere. The ability of these gases to capture heat is what causes the greenhouse effect.

• GHE is a thermal process in which the heat (Infrared) gets trapped into the atmosphere, under the action of GHGs. It is a normal natural ~~GHE~~ process which is an essential process.

Now, the normal natural GHE has been speeded up, due to the increasing levels of GHGs, converted into an enhanced GHE.

2. GHG (Green house gases) :- (major cause to global warming)

• Green house gases naturally blanket the earth and keep it about 33 degree Celsius warmer than it would be without these gases in the atmosphere. This is called green house effect.

• Over the past century, the Earth has increased in temperature by 0.5 degree Celsius and many scientists believe this is because increase in concentration of the main greenhouse gases; Carbon dioxide, methane, CFCs & nitrous oxide - ~~and~~

• These greenhouse gases has the ability to absorb, trap and scatter heat.

1. Carbon dioxide :-

• Carbon dioxide (CO_2) is a colorless, odorless, non-flammable gas and is the most prominent greenhouse gas in Earth atmosphere.

• Carbon dioxide is recycled through the process of photosynthesis, which makes human life possible. ^{61%} ∴ CO₂ produce greenhouse gas

• Carbon dioxide is emitted into the air as human exhale, burn fossil fuel for energy and deforest the plants.

• An isolated test at Mauna in Hawaii revealed more than 12% (316 ppm in 1959 to 360 ppm in 1996) increased in mean annual conc of CO₂.

• The world energy council reported that global CO₂ emission from burning fossil fuels rose 12% between 1990 and 1995. The increase from developing countries was three times that from developed countries.

• Carbon dioxide is emitted by deforestation. The cause of deforestation are logging for lumber, pulpwood and fuelwood.

• Forests and wooded areas are natural carbon sinks. This means that as trees absorb carbon dioxide, and release oxygen, carbon dioxide is being put into trees. This process occurs naturally by photosynthesis, which occurs less and less as we cut and burn down trees. As the abundance of trees declines, less CO₂ can be recycled.

• As we burn them down, carbon is released into the air and carbon bonds with oxygen to form CO₂, adding greenhouse effect.

b. Methane :- ∴ Methane contribute 15% of greenhouse gas.

• Methane is a colorless, odorless, flammable gas. It is formed when plants decay and where there is little air. It is often called swamp gas because it is abundant around water and swamps.

• Sources of methane emission is raising livestock, coal mining, drilling for oil and natural gas, rice cultivation and garbage sitting in landfills.

c. Nitrous oxide : N₂O contribute 4% in GHGs.

• Nitrous oxide is also colorless greenhouse gas but is sweet in odor.

• N₂O released naturally from oceans and by bacteria in soil.

• Each year we add 7-13 millions tons into the atmosphere by using

Nitrogen base fertilizers, disposing of human and animal wastes in sewage treatment plants, at automobile exhaust, and other -

• It is important to reduce emissions because the nitrous oxide we release today will be trapped in the atmosphere 100 years from now (World Book Volume 13) -

9. Fluorocarbons :- Contribute 11% in GHGs.

- Fluorocarbon is a general term for any group of synthetic organic compounds that contain fluorine and carbon -
- Many of these compounds, such as chlorofluorocarbon (CFCs) can be easily converted from gas to liquid or liquid to gas -
- Because of these properties CFCs can be easily used in aerosol cans, refrigerators, and air conditioners.
- When CFCs are emitted into atmosphere, it break down molecules in the ozone layer - (World Book) -

3. Depletion of Ozone layer :-

• Ozone is a variant of oxygen, the ozone molecule having three atoms of oxygen. Ozone is a poisonous gas and if inhaled can cause death. Ozone layer surround the earth's stratosphere which is about 11 km above the earth surface.

• Ozone layer efficiently screen all the harmful ultraviolet rays of the sun by absorbing most of the dangerous ultraviolet B (UV-B) radiations (ultra-violet A is allowed through while UV-C is captured by oxygen) -

• Life on earth has been safe-guarded for thousand of years because of this life-protecting layer. Ozone layer act as shield to protect the earth against the harmful ultraviolet radiation from sun.

• Ozone layer is destroyed by many chemicals released by human activities e.g halocarbons.

- Halocarbon are a group of compounds which are mostly man-made and contain carbon and halogen (F, Cl, Br, I). They are artificially produced for industrial purpose.
- Halocarbons are first synthesised in 1928 and is used in propellants in aerosol cans, in manufacturing of foams, in refrigerators and air conditioners and as cleaning solvents.
- Halocarbons group include CFCs, HCFC and HFCs.
- The stable structure of Halocarbons enables them to attack ozone layer.
- When halocarbons escaped to the atmosphere they drift up to stratosphere and intense UV-C radiations break their chemical bond, releasing Cl, which strip an atom from ozone, reducing it to oxygen atom molecule.
↳ chlorine act as catalyst.
- It has been discovered that one chlorine atom can destroy 100,000 ozone molecules - Thus higher chlorine concentration, the longer will be its impact with ozone layer.
- CFC have more chlorine content than HCFC, therefore CFCs have higher potential for ozone depletion.

4. Population Explosions -

- In the last few decades, growth-rate of populations is phenomenal and the environment is not in a position to sustain the extra load being imposed on it.
- Population explosion has direct as well as indirect bearing on ecosystem - the relation between them is often mysterious, interlinked, compound and complex.
- With rise in number of people increases consumption, production, deforestation, transportation, energy demands and increased solid waste production and as a result increased pollutants to the atmosphere and cause global warming.

As per US Census Bureau,

- In 1960 world population was 3 billion
- In 2000 world population became double - 6 billion
- As of November 25, 2023, population was 8 billion
- Current world population is 8.1 billion.
- As per US Census Bureau predicted that world population may cross 9 billion in coming 8-10 years -
- As world population increases consumption and production increases which results in higher green house gases emissions.
- More people means more energy consumption, especially from fossil fuels like coal, oil and natural gas. These energy sources release CO_2 and other green house gases when burned, trapping heat in the atmosphere and contributing to global warming.

5:- Massive Deforestation:-

- Deforestation is the clearing of earth's forests on a massive scale.
- When trees are cut down or burned it releases large amounts of CO_2 into the atmosphere. Trees play a crucial role in absorbing CO_2 as trees are carbon sinks and storing it through a process called carbon sequestration. When forests are destroyed, this natural process is disrupted, leading to increased levels of CO_2 in atmosphere.
- The release of CO_2 from deforestation contributes to the green house effects, trapping heat in the atmosphere and causing global warming.
- According to global forest watch, more than 10 million have been deforested over the past 3-4 years -
- As per "NOAA" (National oceanic and atmospheric Administration) CO_2 level is 424 ppm (parts per million).

6:- Rapid urbanization:-

- Urbanization is the influx of people to cities.
- Urbanization refers to increase in a country's urban relative to its.

rural population (United Nations 2014; IOM 2015) -

• In 1950, approximately 30% of the world's population lived in urban areas. By the 2010s, this share had increased to over 50% and approximately 66% of the world's population is projected to live in cities by 2050 (United Nations 2014).

• As more people move to cities, there is a higher demand for infrastructure transportation and energy, leading to increased greenhouse gas emissions.

7. Rapid Industrialization -

• Rapid industrialization can significantly contribute to global warming -

• When industries grow quickly, they often rely on fossil fuels like coal, oil, and natural gas for energy production. Burning these fuels releases large amounts of greenhouse gases, such as CO_2 , CH_4 into atmosphere.

• Thermal power industry release CO_2 , CO and NO_x

• Steel industry release CO_2 and VOCs -

• Fertilizers industry release CH_4 , N_2O , NO_x and CO_2 .

• Paper industry release CO_2 , CO and SO_2 .

• Textile/Pesticide/pharma industries release CO_2 , CO, SO_2 etc.

8. Generation of Solid waste :-

• Due to increasing population and prosperity, industrial/municipal-domestic waste/Agricultural waste has increased significantly, resulting in serious problems on public health and the environment -

• Every single person is affected by generation of solid waste.

• Human activities generate municipal solid waste due to improper utilization of energy and resources (Lalohadiqand, 2015)

• As solid waste release CO_2 and CH_4 , CH_4 has much more global warming potential than CO_2 -

• During the first 20 years of release, CH_4 has 72 times more global warming capacity than CO_2 and even after 100 years, the capacity remains up to 25 times more (Fei, 2016)

• Globally, the annual CH_4 emissions from solid waste landfills were

estimated at 31 MT CH₄ or 799 MT CO₂ eq- in 2010, amounting to approximately 11% of total global emissions (GMI, 2013)-

• LFGs two major components are CH₄ and CO₂, if not captured, it will increase the greenhouse effect and bring bad smell to the surrounding environment (Chen, 2016).

• UNEP (United Nations Environment Program) Established in 1972-

• According to UNEP more than 350 million tons annually waste is generated.

• According to UNEP, Pakistan generate 15 million tons - per/annually ^{in 2023}

Adaptation of wild fires:-

9. Fossil Fuel:-

Fossil fuels, such as coal, oil and natural gas, are major contributors to global warming due to green house gases, when burned for energy.

a) Carbon dioxide:- The combustion of fossil fuels releases large amounts of carbon dioxide into the atmosphere. According to IPCC, about 76% of global anthropogenic greenhouse gases emissions are carbon dioxide emissions, primarily from burning of fossil fuels. In 2019 alone, global carbon dioxide emissions from fossil fuels and industry reached a record high of 36.8bn metric tons. (source: IPCC ^{special} Report on global warming of 1.5°C: global carbon project).

b) Methane Emission:- Fossil fuel extraction, particularly natural gas production release methane as potent green house gas. CH₄ is more potent than CO₂. The oil and gas sector is the largest industrial source of CH₄ globally.

In 2019, the oil and gas industry emitted approximately 82 million metric tons of methane (source: International Energy Agency: Environmental Defense Fund).