Global Warming

"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. "
It is primarily caused by CO_2 emission by man-made activities.
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.

Causes of Global Warming
Following are the major causes of global warming:

Man-made Causes of Global Warming
- **Deforestation**
- **Use of Vehicles**
- **Chlorofluorocarbon**
- **Industrial Development**
- **Agriculture**
- **Overpopulation**

Natural Causes of Global Warming
- **Volcanoes**
  The ash and smoke emitted during volcanic eruptions goes out into the atmosphere and affects the climate.
- **Water Vapour**
- **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**

Effects of Global Warming
Following are the major effects of global warming:
- Rise in Temperature
- Threats to the Ecosystem
- Climate Change
- Spread of Diseases
- High Mortality Rates
- Loss of Natural Habitat
- Melting of polar ice caps, and increase of sea/ocean levels
- Flooding of low-lying land
- Less water vapour in the atmosphere leading to more drought
- Causes weather hurricanes, flooding & droughts, difficulties in growing crops

Remedial Measures
- Enhance energy efficiency during use by adding insulation to your walls, and by using CFL bulbs, etc.
- Reduce transport sector emissions by less and smart driving.
- Promote renewable energy (like solar energy) usage.
- Remove subsidies on fossil fuels.
- Favour sustainable agriculture.
- Recover methane emissions through waste management.
- Promote afforestation and reforestations—a single tree will absorb approximately one ton of CO_2 during its lifetime.

- Enhance energy efficiency during generation, transmission, and distribution.
- Reduce waste, prefer reusable products, recycle paper, plastic, metals, etc.

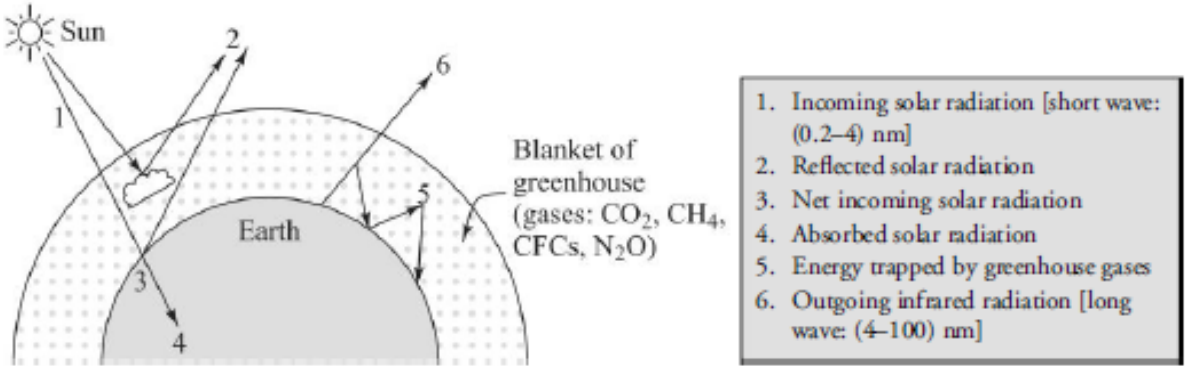
Greenhouse Effect

"Greenhouse effect is the process by which radiations from the sun are absorbed by the greenhouse gases and not reflected into space. This insulates the surface of the earth and prevents it from freezing."

During the day the sun heats up the earth's atmosphere. At night, when the earth cools down the heat is radiated back into the atmosphere. During this process, the heat is absorbed by the greenhouse gases in the earth's atmosphere. This is what makes the surface of the earth warmer, that makes the survival of living beings on earth possible.

However, due to the increased levels of greenhouse gases, the temperature of the earth has increased considerably. This has led to several drastic effects.

Greenhouse effect is illustrated as



Greenhouse Gases

"Greenhouse gases are the gases that absorb the infrared radiations and create a greenhouse effect.

The major greenhouse gases are:

1) Carbon dioxide
2) Methane
3) Water
4) Nitrous oxide
5) Ozone
6) Chlorofluorocarbons (CFCs)

Causes of Greenhouse Effect

The major causes of the greenhouse effect are:

- **Burning of Fossil Fuels**
- **Deforestation**
- **Farming-**Nitrous oxide used in fertilizers is one of the contributors to the greenhouse effect in the atmosphere.
- **Industrial Waste and Landfills**

Effects of Greenhouse Effect

The main effects of increased greenhouse gases are:

Global Warming

It is the phenomenon of a gradual increase in the average temperature of the Earth's atmosphere. The main cause for this environmental issue is the increased volumes of greenhouse gases such as carbon dioxide and methane.

Depletion of Ozone Layer
Ozone Layer protects the earth from harmful ultraviolet rays from the sun. The depletion of the ozone layer results in the entry of the harmful UV rays to the earth's surface that might lead to skin cancer and can also change the climate drastically.

Smog and Air Pollution
Smog is formed by the combination of smoke and fog. It can be caused both by natural means and man-made activities.

Acidification of Water Bodies
Increase in the total amount of greenhouse gases in the air has turned most of the world's water bodies acidic. The greenhouse gases mix with the rainwater and fall as acid rain. This leads to the acidification of water bodies.

Runaway Greenhouse Effect
This phenomenon occurs when the planet absorbs more radiation than it can radiate back. Thus, the heat lost from the earth's surface is less and the temperature of the planet keeps rising. Scientists believe that this phenomenon took place on the surface of Venus billions of years ago.

Climate change

Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural, such as through variations in the solar cycle. Human actions are causing Earth to warm by increasing the amount of carbon dioxide in the atmosphere.
Climate change is reflected from the following facts:

- Since the late 19th century, the earth has warmed by 0.3 to 0.6°C on an average.
- By the year 2100,
  - Temperatures would rise by 1 to 3.5°C
  - Global mean sea levels would rise by 15 to 95 cm

The main causes of climate change include:

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

The most common effects of climate change:

- Extreme Heat
- Changing Rainfall Patterns
- Droughts
- Glacier Melt
- Sea level rise
- Floods
- Increase in precipitation
- The amount of carbon dioxide in the atmosphere has risen by 25% since 1958, and by about 40% since the Industrial Revolution
- Food supplies and agriculture also depend on climatic conditions
- It also hugely impacts human health.

Solutions to Climate Change

- Reduce the emission of greenhouse gases
- Use renewable energy resources

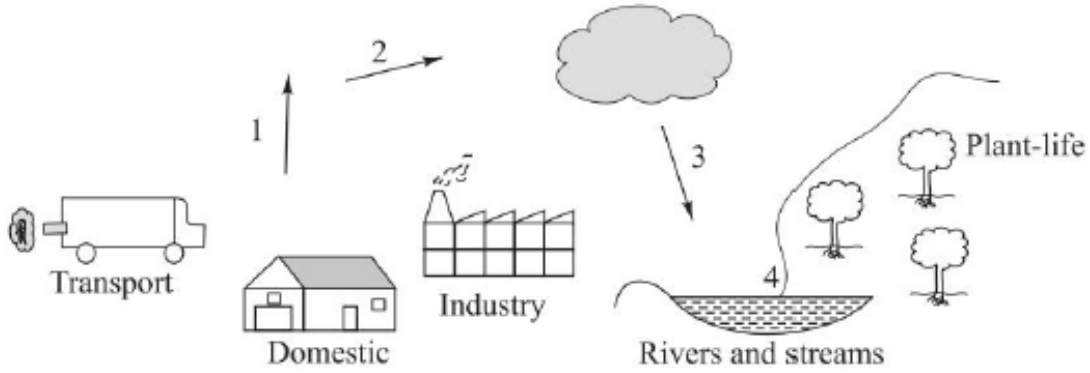
- Use energy efficient technologies
- Ending Our Reliance on Fossil Fuels.
- Sustainable Transportation.
- Sustainable Buildings.
- Better Forestry Management and Sustainable Agriculture.
- Conservation-Based Solutions.
- Industrial Solutions.

Acid Rain

Acid rain is rain which is unusually acidic (pH of less than the natural range of 5 to 6); caused mainly by atmospheric pollution with sulphur dioxide and nitrogen compounds.

The causes of acid rain are ***Sulphur and Nitrogen particles which get mixed with the wet components of rain***. Sulphur and Nitrogen particles which get mixed with water are found in two ways either man-made i.e as the emissions that are given out from industries or by natural causes like lightning strike in the atmosphere releasing nitrogen oxides and volcanic eruptions releasing sulphur oxide.

$$2SO_2\,(g) + O_2\,(g) + 2H_2O\,(l) \rightarrow 2H_2SO_4\,(aq)$$
$$4NO_2\,(g) + O_2\,(g) + 2H_2O\,(l) \rightarrow 4HNO_3\,(aq)$$



1. Acidic gases (sulphur dioxide and nitrogen oxides) released into atmosphere from industries, vehicle's exhaust, etc.
2. Acidic gases carried by the wind
3. Acidic gases dissolve in rainwater to from acid rain
4. Acid rain kills plant life, pollutes rivers and streams and erodes stonework.

Effects of Acid Rain

- Acid rain is very harmful to agriculture, plants, and animals. It washes away all nutrients which are required for the growth and survival of plants.
- Acid rain affects agriculture by the way it alters the composition of the soil.
- It causes respiratory issues in animals and humans.
- When acid rain falls and flows into the rivers and ponds it affects the aquatic ecosystem. It alters the chemical composition of the water, to a form which is harmful to the aquatic ecosystem to survive and causes water pollution.
- Acid rain also causes the corrosion of water pipes, which further results in leaching of heavy metals such as iron, lead and copper into drinking water.
- It damages the buildings and monuments made up of stones and metals.

pH Value	*Examples*	*Environmental Effects*
4.2–4.4	Acid rain	All fishes die at pH = 4.2
4.5	Acidic lake	Frog eggs, tadpoles, cray fish die at pH = 4.5
5.6	Clean rain	
6.5	Healthy lake	
6.5–6.8	Milk	
7	Pure water	
8	Sea water	

Ozone Layer Depletion

"Ozone layer depletion is the gradual thinning of the earth's ozone layer in the upper atmosphere caused due to the release of chemical compounds, CFCs, chlorine etc from industries or other human activities."

"The ozone layer is a region in the earth's stratosphere that contains high concentrations of ozone and protects the earth from the harmful ultraviolet radiations of the sun."

Ozone (O3) is an allotropic form of oxygen (O2). It is a pale blue gas. It helps in sustaining life on earth by filtering out the sun's harmful ultraviolet radiation. Across the globe, in the stratosphere, the average thickness of the ozone layer is about 3 mm at 0°C and 1 atm pressure (or about 300 DU). The total amount of ozone in an overhead column of the atmosphere is measured in dobson unit.

Ozone Hole When the level of ozone in the stratosphere falls below 200 DU, it is considered to represent the beginnings of an ozone hole.

Causes of Ozone-Hole Formation

- The gradual thinning of the ozone layer and ozone-hole formation occurs by the destruction of ozone due to its reactions with nitric oxide, chlorine, hydroxyl radicals, etc., in the stratosphere.
- Chlorofluorocarbons
- Unregulated Rocket Launches
- Nitrogenous Compounds
- nuclear explosions
- Volcanic activity

The chemical reactions leading to the destruction of ozone layer by CFCs are given below:

$$\text{Step (a): } CCl_2F_2 + h\nu \longrightarrow Cl^{\bullet} + {}^{\bullet}CClF_2$$

$$\text{Step (b): } O_3 + Cl^{\bullet} \longrightarrow O_2 + ClO^{\bullet}$$

$$\text{Step (c): } ClO^{\bullet} + O^{\bullet} \longrightarrow Cl^{\bullet} + O_2$$

$$\text{Net reaction: } O_3 + O^{\bullet} \xrightarrow{Cl} 2O_2$$

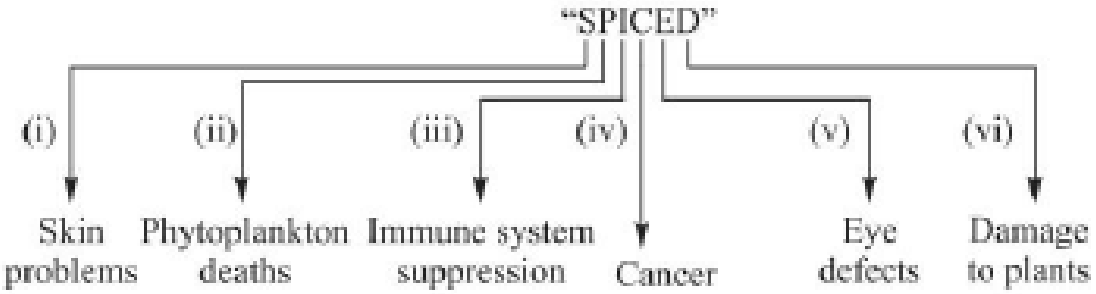
Problems Associated with Ozone-Layer Depletion

The ozone layer absorbs most of the harmful ultraviolet radiations coming from the sun in the region (220–330) nm.

In the absence of an ozone layer, these ultraviolet radiations could cause the following problems:

(i) Swelling of skin and skin cancer; skin aging, burning sensation

(ii) Death of phytoplankton in marine environment (the sole producers)
(iii) Reduction in the body's ability to fight off disease, as UV suppresses the immune system
(iv) Inhibition and alteration of DNA replication and formation of DNA adduct; leukamia, breast cancer
(v) Visual impairment, dizziness, cataracts of eyes
(vi) Damage to plants; reduction in crop yields; faster deterioration of paints, fabrics, plastics



Remedial Measures to Control the Depletion of Ozone Layer
(i) Avoid any fire extinguisher that contains bromine-based halons. Preferably use water, carbon dioxide or dry chemical fi re extinguishers.
(ii) Spread awareness about the restricted use of CFCs for the healthy survival of mankind.
(iii) Avoid purchasing and using refrigerators, air conditioners, etc., which use CFCs, freons, etc., as coolants.
(iv) Avoid purchasing and using pressurised aerosol cans which use CFCs, freons, etc., as propellants.
(v) Ban atmospheric nuclear explosions, as they emit NO and deplete the ozone layer.
(vi) Reduce the air traffic of supersonic aircrafts that fly at the ozonosphere altitude, as they release large amounts of NO and deplete the ozone layer.
(vii) Facilitate advanced research to plug the ozone holes that have already been formed.

POPULATION GROWTH
Population is a group of organisms of a particular species, sharing a particular characteristic of interest, most often that of living in each area at a specific time.
Population growth is the change in a population per unit time. Population growth can be positive, static or negative.

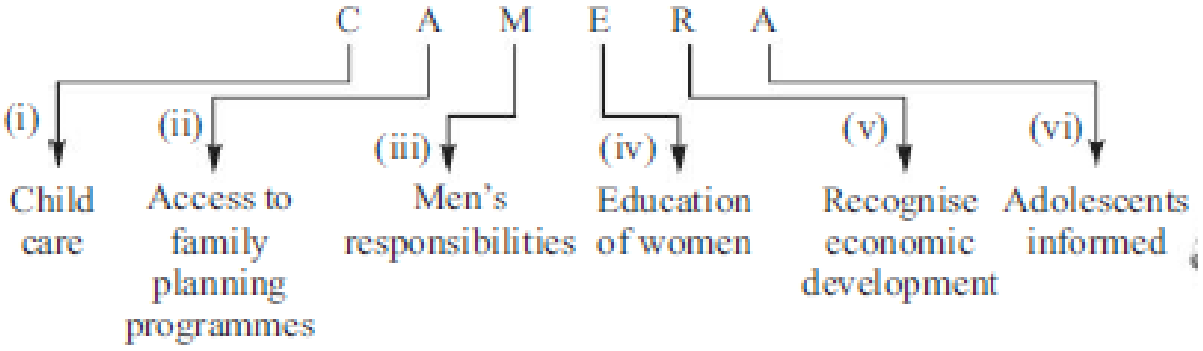
Population Explosion
Population explosion means extremely fast rise in the number of people.

Year	1951	1961	1971	1981	1991	2001
Population (Millions)	361	439	548	683	846	1027

Population Explosion in Indian Context India alone has about 16% of the world's population. India has a population growth rate of about 2.15%. Population growth is the reason for every environmental problem faced by Indian citizens:
(i) Ecosystems and biodiversity is in danger.
(ii) Forests have been declining.
(iii) Water and other natural resources are diminishing.
(iv) Major population lacks basic amenities of living such as water, food, health care, etc.
(v) India is facing energy crisis.
(vi) Due to upcoming shelter needs for the growing population, agricultural land is shrinking and leading to food crisis.
(vii) Population explosion has resulted in overcrowding, creation of slums, etc.

Population Policy
Population policy means measures instituted by a government to influence size, growth,

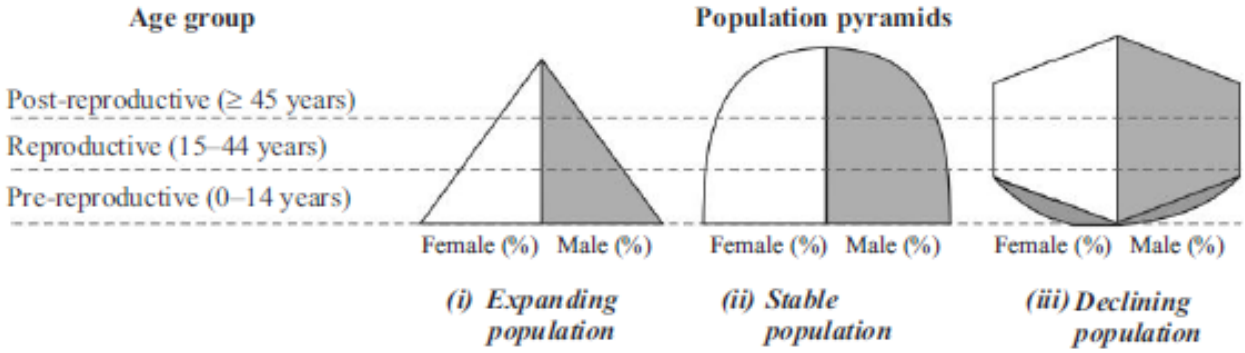
distribution or composition of population.
The objectives of a good population policy are the following:
(i) Proper child care.
(ii) Provide universal access to family planning and reproductive health programmes and to information and education regarding these programmes.
(iii) Ensure that men fulfil their responsibility to ensure healthy pregnancies, proper child care, promotion of women's worth and dignity, etc.
(iv) Make women equal participants in all aspects of society—by increasing women's education, health, and employment.
(v) Recognise that economic development is essential for environmental protection.
(vi) Provide information for adolescents (by increasing their access to education) to prevent unwanted pregnancies, unsafe abortion, and the spread of AIDS and sexually transmitted diseases.



Population Stabilisation
Population stabilisation means the attainment of zero growth, in which the number of births in a population equals the number of deaths.
Population stabilisation occurs when parents have enough children to replace them in population.

Population Pyramids
Age distribution influences both birth and death rates. In any ecological population, there are mainly three age groups: **Pre-reproductive (0–14 years), reproductive (15–44 years) and post-reproductive (45 years and above).** The proportion of different age groups in any population is generally expressed graphically in the form of population (or age) pyramids. There are three types of population pyramids.

(A) Broad-based Pyramid or Expanding-age Pyramid
(B) Bell-shaped Polygon
(C) Urn-shaped Pyramid



Population Forecasting Methods
(A) **Arithmetical Increase Method**: Future population is calculated by using the following formula

$$P_x = P_0 + x\ I$$

where ,Px is forecasted population in the 'x' decade
P_0 is present population
x is number of decades between P0 and Px
I is average increase of population in a decade

(B) Geometric Increase Method

$$P_x = P_0\left(1+\frac{r}{100}\right)^x$$

Where, Px is forecasted population in the 'x' decade
P0 is present population
x is number of decades between P0 and Px
r is the percentage growth rate of population

Automobile pollution

Automobile air pollution are **emissions from cars and other vehicular traffic consisting chiefly of carbon monoxide, nitrogen oxides, unburned gasoline, carbon dioxide and lead**.
Automobiles are a necessary evil, while they have made living easy and convenient, they have also made human life more complicated and vulnerable to both toxic emissions and an increased risk of accidents.

Sources of Automobile Pollutants:

i. Hydrocarbons

ii. Carbon monoxide (CO)

iii. Nitrogen oxides (NO_x)

iv. Particulate matter

v. Sulfur oxide (SO_x)

Effect of Automobile Pollutants:

1. Prolonged exposure to hydrocarbons contributes to asthma, liver disease, and cancer, overexposure of carbon monoxide poisoning may be fatal.
2. NOx is a precursor to smog and acid rain. NOx is a mixture of NO and NO2. NO2 destroys resistance to respiratory infection.
3. Particulate matter causes negative health effects, including but not limited to respiratory disease.
4. Oil, petroleum products and other toxins from automobiles kill fish, plants, aquatic life and even people.

Control of Automobile Pollution:

1. Engine efficiency has been steadily improved with improved engine design.
2. One of the first-developed exhaust emission control systems is secondary air injection.
3. Reduce use, and car pool.
4. Monitor and repair any leaks.
5. Using good quality automobile fuels – which have cleaner emissions.
6. Using lead-free petrol - Leaded petrol causes heart disease, stroke and cancer.
7. Greater use of compressed natural gas (CNG) - It is cleaner than petrol and diesel.

Burning of paddy straw

Besides causing air pollution, burning of paddy straw **leads to the loss of soil organic matter and essential nutrients, reduces microbial activities and the land more vulnerable to soil erosion**.

In order to quickly prepare their fields for the wheat crop, many farmers simply **burn leftover plant debris after harvesting rice**. The practice is known as paddy stubble burning.

Advantages of Stubble Burning

1. It is the cheapest and quickest way to deal with crop waste.
2. It destroys weeds including those that are resistant to herbicides.
3. It kills other pests also, such as slugs.

Effects of stubble burning

1. Pollution
2. Soil fertility: Burning stubble also adversely affects soil fertility. It destroys the soil's nutrients making it less fertile.
3. A lot of nitrogen, potassium, sulphur, phosphorous as well as organic carbon are destroyed every year on account of stubble burning.

Solutions to stubble burning

A few solutions to the problem of stubble burning are discussed below.

1. Incentivise farmers for not burning the stubble and provide economic value for the crop residue. The stubble can be converted into fodder or organic fertilizer or fuel.
2. Efforts should be made to improve the combine harvester that farmers use to harvest the crop.
3. Encourage and incentivise the farmers to go for early paddy, to give them enough time to harvest and thereafter prepare their fields for the next Rabi crop.
4. Encourage farmers to sow alternate crops and shift them away in the long run from paddy to maize, fruits, vegetables, and cotton.
5. Farmers have a difficult time unlearning the practice of stubble burning and they should be educated about its ill effects and offered attractive alternatives.