

Energy and Environment Science

L-T-P-C: 2-0-0-2

Syllabus:

Unit – 1 [4 Hours]: Present Energy resources in India and its sustainability:

Energy Demand Scenario in India, Different type of **conventional Power Plant**, Advantage and Disadvantage of conventional Power Plants, **Conventional vs Non- conventional power generation**.

Unit – 2 [4 Hours]: Basics of Solar Energy: Solar Thermal Energy; Solar Photovoltaic: Advantages and Disadvantages, Environmental impacts and safety.

Unit – 3 [4 Hours]: Wind Energy: Power and energy from wind turbines, India's wind energy potential, **Types of wind turbines, Offshore Wind energy**, Environmental benefits and impacts.

Unit – 4 [4 Hours]: Biomass Resources: Biomass conversion Technologies, Feedstock pre-processing and treatment methods, Bioenergy program in India, Environmental benefits and impacts; **Other energy sources: Geothermal Energy resources, Ocean Thermal Energy Conversion, Tidal Energy.**

Unit – 5 [4 Hours]: Air pollution: Sources, effects, control, air quality standards, air pollution act, air pollution measurement; **Water Pollution:** Sources and impacts; **Soil Pollution:** Sources and impacts, disposal of solid waste. **Noise pollution**

Unit – 6 [4 Hours]: Greenhouse gases effect, acid rain; Pollution aspects of various power plants; **Fossil fuels and impacts, Industrial and transport emissions impacts.**

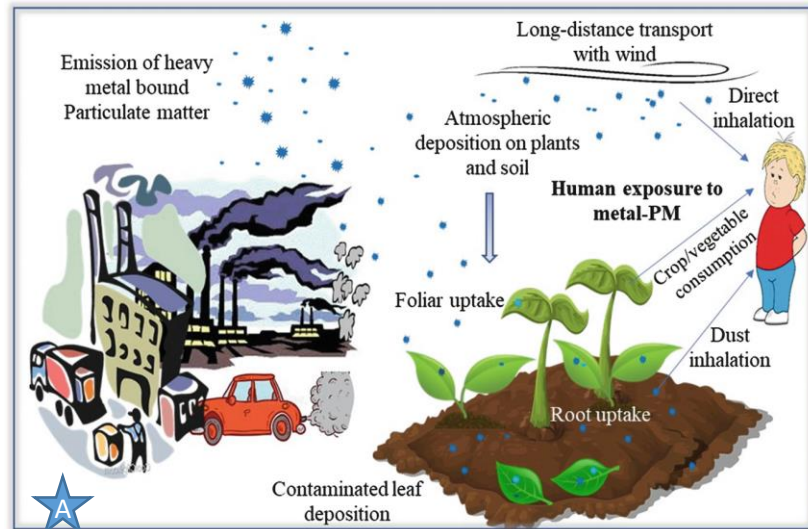
Climate Change issues and environmental impacts

Contents

- Energy and Environment
- Greenhouse gases effect
- Global Warming and Climatic Change Impacts
- Acid Rain

Energy and Environment

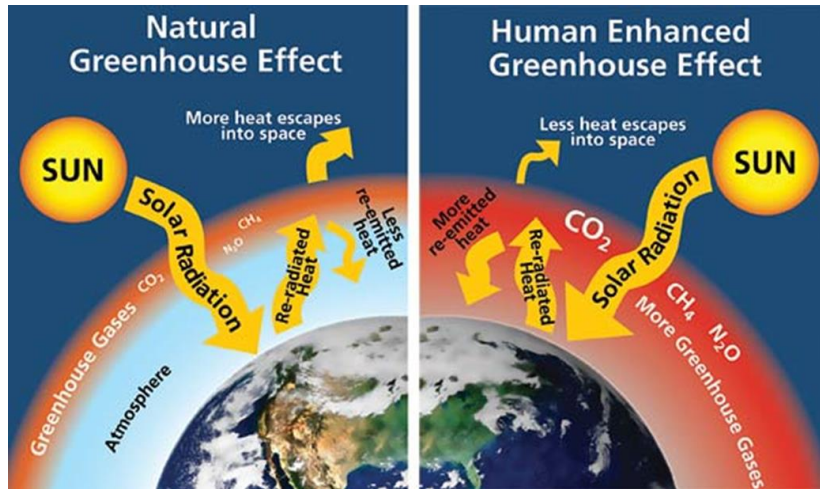
Emissions Due to Energy Use



❑ The principal emissions causing impact on the air environment are particulate matter (dust), Sulphur oxides, nitrogen oxides, and carbon monoxide.

1. **Particulate matter** - Generated from the combustion of solid fuels like coal, lignite, biomass etc. (**ash content**)
2. **Sulphur oxide (SO_x)** emissions mainly occur from combustion of oil and coal due to **sulphur content**.
3. **Nitrogen oxides (NO_x)** emissions are also associated with fuel combustion and air
4. **SO_x and NO_x** emissions lead to acid rain which is a trans-boundary environmental issue
5. **Carbon dioxide** is a major contributor to global warming and climatic change though **it is not consider as pollutants.**

Global Warming and Climatic Change



- Atmosphere is composed mainly of 21% Oxygen, 78% Nitrogen, 0.04% carbon dioxide, and Argon 0.04% by volume
- The two most important layers in the atmosphere are known as the troposphere and the stratosphere. 90% of all the molecules in the atmosphere are in the troposphere.

What is the Greenhouse Effect

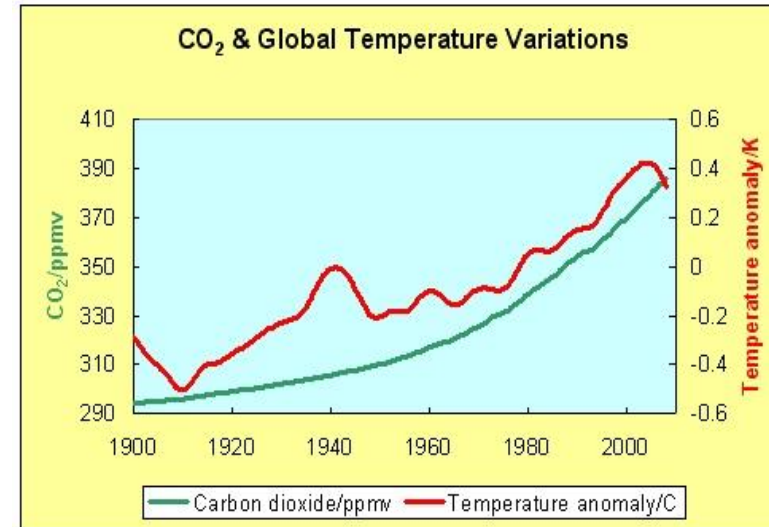
- ❑ Greenhouse gases are those gases in the atmosphere which by absorbing thermal radiation emitted by the earth's surface have a **blanketing effect** over the surface keeping it warmer .
- ❑ Without naturally occurring greenhouse gases such as water vapor, carbon dioxide, methane and nitrous oxide, the earth's average **surface temperature would be a cold -18°C rather than the tolerable 15°C**. This warming of the earth called the greenhouse effect

What is the Enhanced Greenhouse Effect

Natural greenhouse effect is **enhanced by** the increase of greenhouse gases in the atmosphere **especially carbon dioxide** from burning of fossil fuels, coal, oil and gas, together with wide deforestation over the past 200 years and more substantially over the past 50 years

Water vapor is also considered as greenhouse gas & it is not changing directly because of human activities.

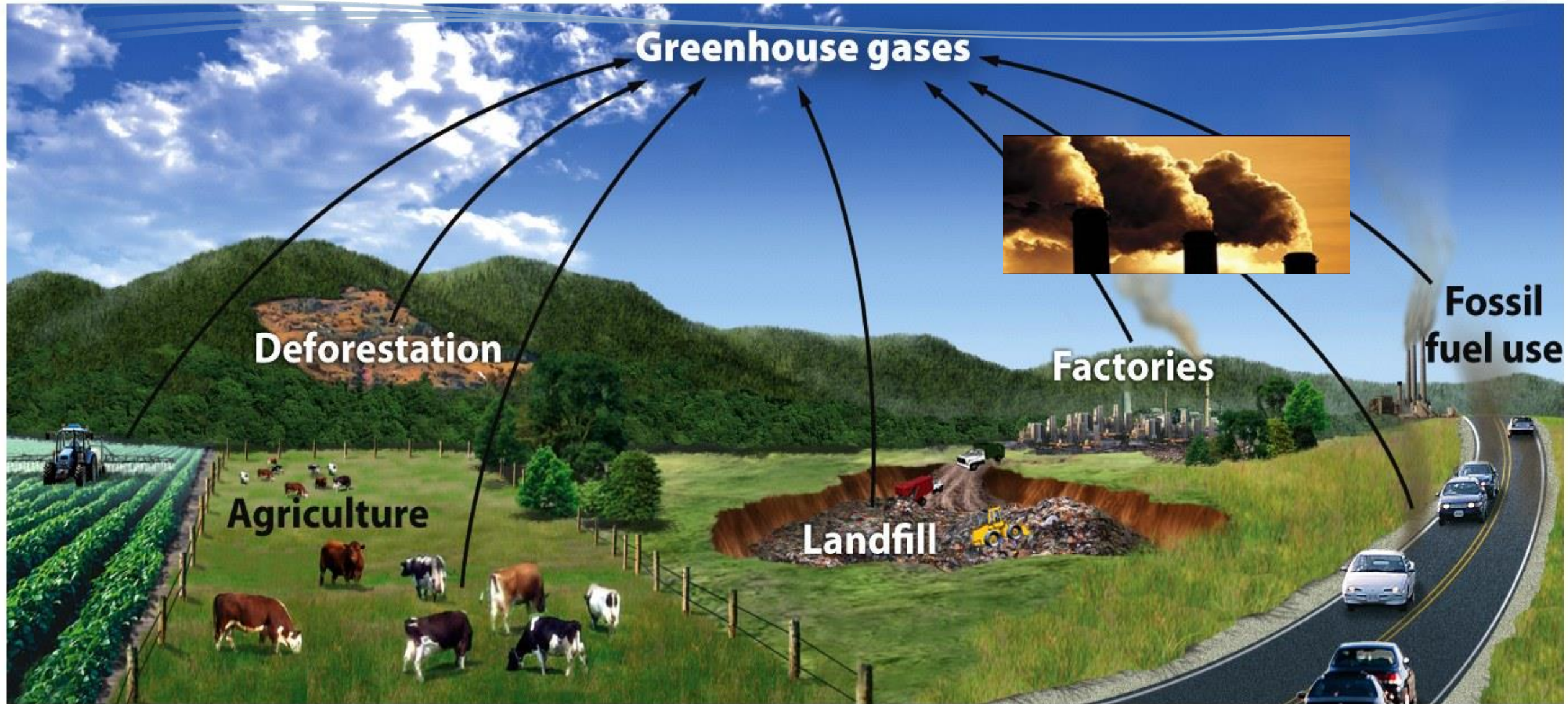
carbon dioxide, methane, nitrous oxide, the chlorofluorocarbons (CFCs) and ozone. are directly influenced by human activities



Rising Global Temperatures

Estimated : earth's average temperature has risen by 0.75°C since 1880 because of emissions of greenhouse **gases from human activity**. The relation between CO₂ and global temperature variations is shown

Green House Gas – Major Causes



Global Greenhouse Gas Emissions



- Since the Industrial Revolution, annual CO_2 emissions from fuel combustion dramatically increased
- Agriculture activity producing small shares of CH_4 and N_2O from domestic livestock and rice cultivation,
- CO_2 from fossil fuels & cement contributes almost 70% of global GHG emissions

India's Greenhouse Gas Emissions

- India contributed to almost 7% of global emissions
- India is world's fourth largest contributor in terms of CO_2 emissions (5%) behind China (22%), USA(20%) and Russia. Major source - coal, petroleum, N.gas

What are the Greenhouse Gases?

1. Carbon Dioxide

- Carbon dioxide is the largest greenhouse gases with atmospheric lifetime of over 100 years.

Carbon Sequestration

- It is the term** given to the **process of removing CO₂ from large point sources** such as power plant, oil refineries, industrial process.
- The CO₂ is then stored in depleted oil and gas reservoirs or saline reservoirs. Oceans are a major CO₂ sink. Trees and grasses store about three times more CO₂ than the atmosphere.

2. Methane

- from wetlands and anaerobic decomposition.

3. Nitrous Oxide

- from use of nitrogen fertilizer, *fossil fuel combustion*

4. Chlorofluorocarbons (CFCs)

The CFCs are man-made chemicals which vaporise just below room temperature and are non-toxic and non-flammable.

5. Perfluorocarbons

Primary aluminum production and semiconductor manufacture are the largest known man-made sources of perfluorocarbons.

6. Sulphur Hexafluoride (SF₆)

Sulfur hexafluoride is the most potent greenhouse gas. It is used in insulation, electric power transmission equipment.

7. Ozone

Ground-level ozone forms from Volatile Organic Compounds (VOCs) and nitrogen oxides in the presence of heat and UV radiation.

Global Warming Potential (GWP)

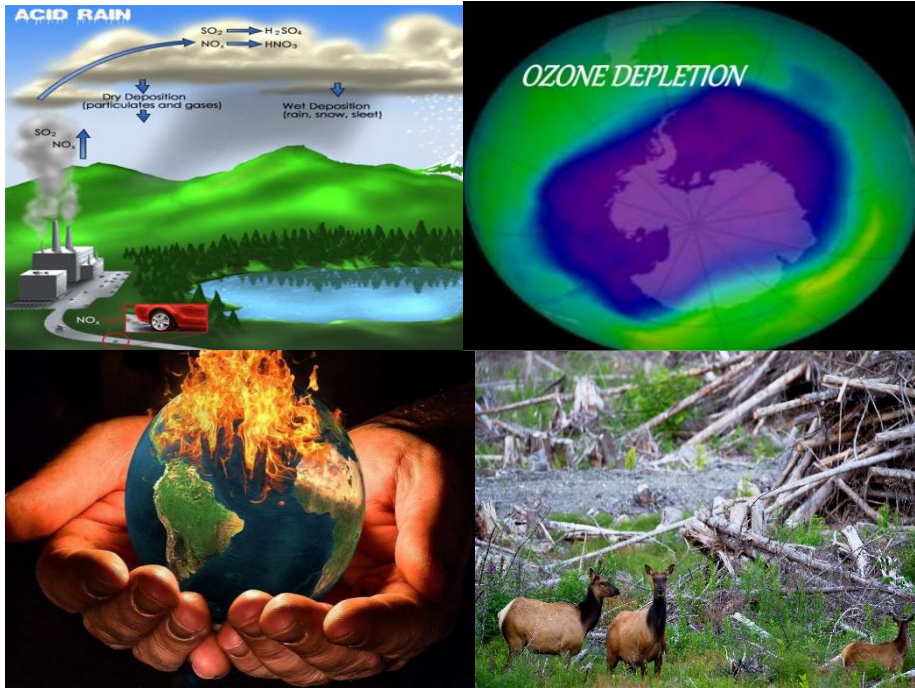
Increasing Concentration of Atmospheric Greenhouse Gases

Greenhouse gas	Baseline	Current level	GWP	Lifetime in atmosphere (years)
Carbon dioxide (CO ₂)	280 ppm	395 ppm	1	5-200
Methane (CH ₄)	700 ppb	1893 ppb	23	12
Nitrous oxide (N ₂ O)	275 ppb	326 ppb	300	114
Ozone	-	-	-	Days/weeks
Chlorofluorocarbons (CFC) and related chemicals	0	ppt levels	4000-8000	5-100
Perfluoromethane, one of the Perfluorocarbons(PFC)	40 ppt	80 ppt	5700	50000
Sulphur hexafluoride (SF ₆)	0.01 ppt	7.79 ppt	22000	3200

- Atmospheric lifetime of CO₂ is over 100 years.
- Some greenhouse gases are 140 to 23,900 times more potent than CO₂ in terms of their ability to trap and hold heat in the atmosphere over a 100-year period.
- GWP a measure of the “potential for global warming per unit mass relative to carbon dioxide
- If methane has a GWP of 23 and carbon has a GWP of 1 (the standard), this means that methane is 23 times more powerful than CO₂ as a greenhouse gas
- The higher the GWP value, the larger the infrared absorption and the longer the atmospheric lifetime.
- The increasing concentration of greenhouse gases, GWP and lifetime is given in Table below

1 ppm = 1g in 1000 kg,
 1 ppb = 1 g in 1000 tonnes,
 1 ppt = 1 g in 1000 000 tonnes

10.2 Global Environmental Issues



The key environmental issues of global significance are

- ☐ Acid rain
- ☐ Ozone layer depletion
- ☐ Global warming and climatic change
- ☐ Loss of biodiversity

10.3 Acid Rain caused by release of Sulphur oxides and Nitrogen oxides which then mix with water vapor in atmosphere to form sulphuric and nitric acids

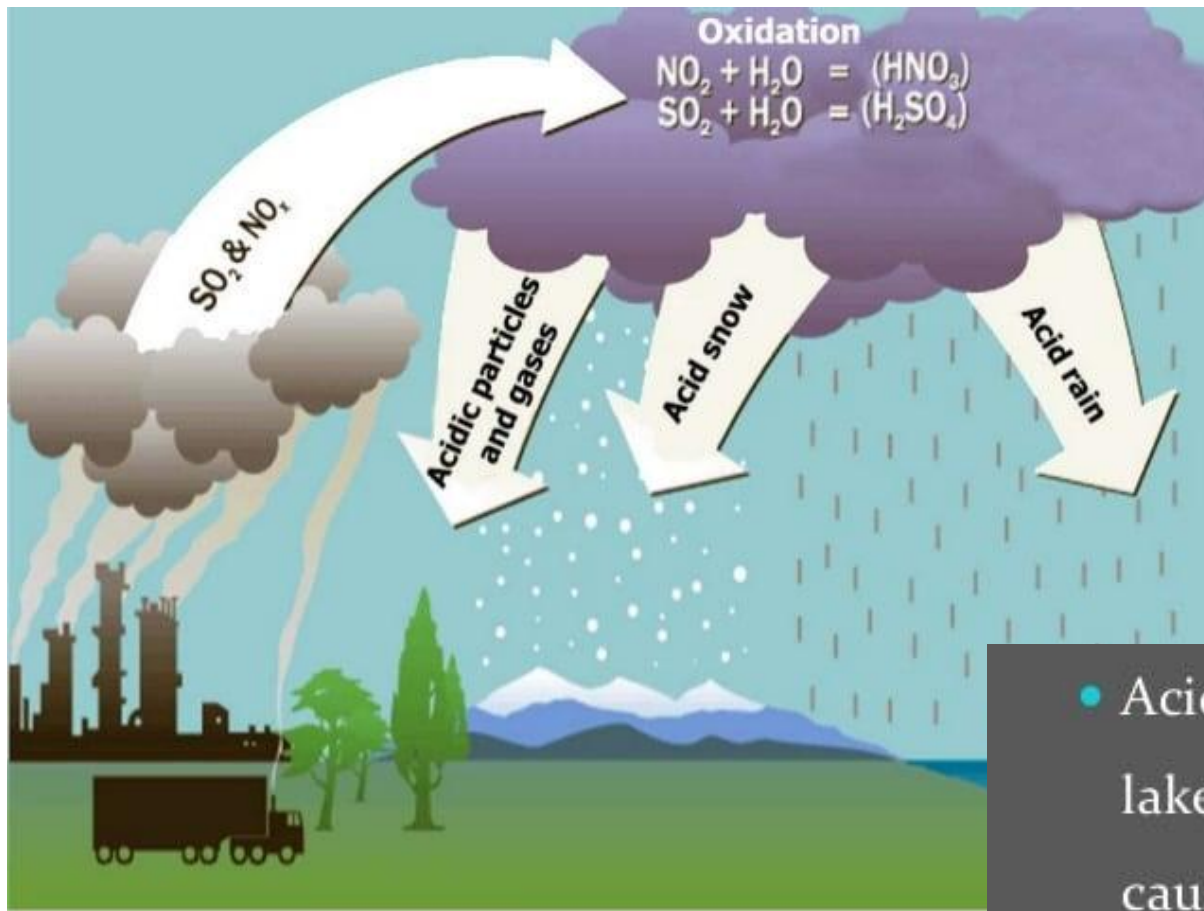
Effects of acid rain are : Acidification of lakes, streams, and soils ,Direct effects (release of metals) , Killing of wildlife (trees, aquatic plants, animals) , Decay of building materials paint, and Health problems

10.6 Global Warming and Climatic Change Impacts

- ☐ Increasing Ocean Temperature and Rising Sea Levels
- ☐ Snow and Ice Melting
- ☐ Altered Rainfall Patterns
- ☐ Extreme Weather Events
- ☐ More Severe Heat Waves
- ☐ Loss of Biodiversity
- ☐ Increased Diseases
- ☐ Dwindling Freshwater Supply
- ☐ Food Shortages







- Acid rain is a big problem. It causes the death of our lakes, our rivers, wildlife and also harms people. It also causes other problems which are also very serious such as the release of aluminum and lead in our water supplies. Unfortunately, we suffer because of this. Hopefully acid rain in the future will be reduced as a result of the measures taken.

- Because the various gases of fossil fuels like oil and coal, often contains (acidic) oxides of sulfur and nitrogen, among others, this produces acid rain containing dissolved corresponding acids.



Consequences

Acid rain has a strong impact on natural ecosystems (forests, wetlands, soil), directly or indirectly killing life forms, but also in residential ecosystems, eroding historical monuments, causing damage to buildings and vehicles, but also directly harming human health.



EFFECTS OF ACID RAIN

People, forest, soil, lakes and rivers and the animals are affected by **acid rain**. When the acid rain falls on the forests, the trees die including the different animal species living there.

The soil is ruined of its nutrients and therefore, the plants will not grow for animals to eat and live. In addition, the bodies of water become acidic, killing the fish and the plants grown in that place.



Remedies

- ▶ Reduced emissions
- ▶ Create awareness
- ▶ Plantation of Trees
- ▶ Renewable and clean source of energy
- ▶ More efforts by government
- ▶ Protecting coral reefs



Conclusion

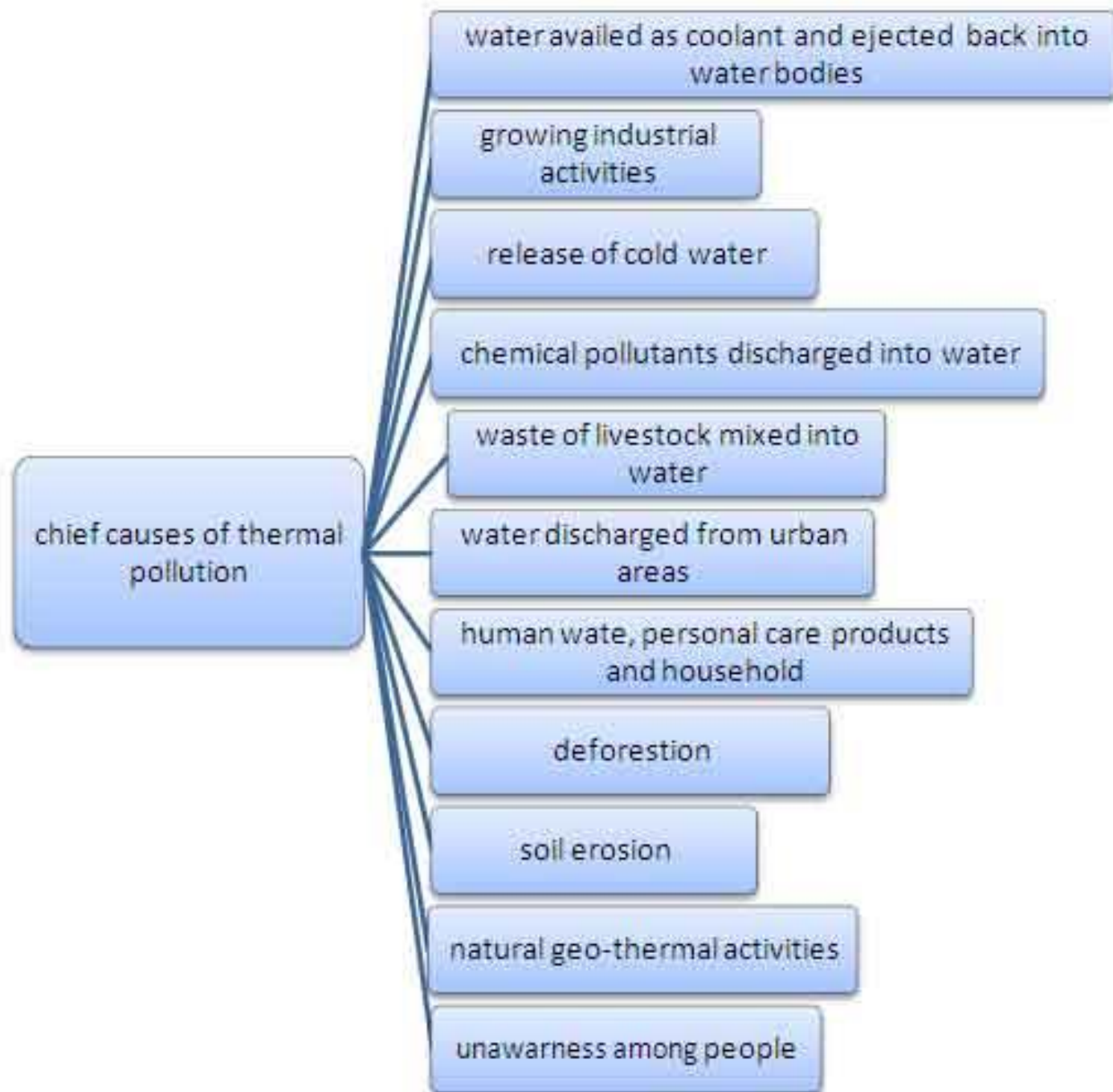
Global warming is affecting plants, animals, humans and the earth. We need to learn how to conserve our use of fossil fuels to minimize carbon dioxide production. This will slow down the effects of global warming.

Thank You



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Save energy and water for Sustainable Life



Fossil fuel, biomass, and waste burning power plants

- In the United States, about 65% of total electricity generation in 2018 was produced from fossil fuels (coal, natural gas, and petroleum), materials that come from plants (biomass), and municipal and industrial wastes.
- In India , 75 % electricity is generated from thermal plant
- The substances that occur in combustion gases when these fuels are burned include
 - Carbon dioxide (CO₂)
 - Carbon monoxide (CO)
 - Sulfur dioxide (SO₂)
 - Nitrogen oxides (NO_x)
 - Particulate matter (PM)
 - Heavy metals such as mercury

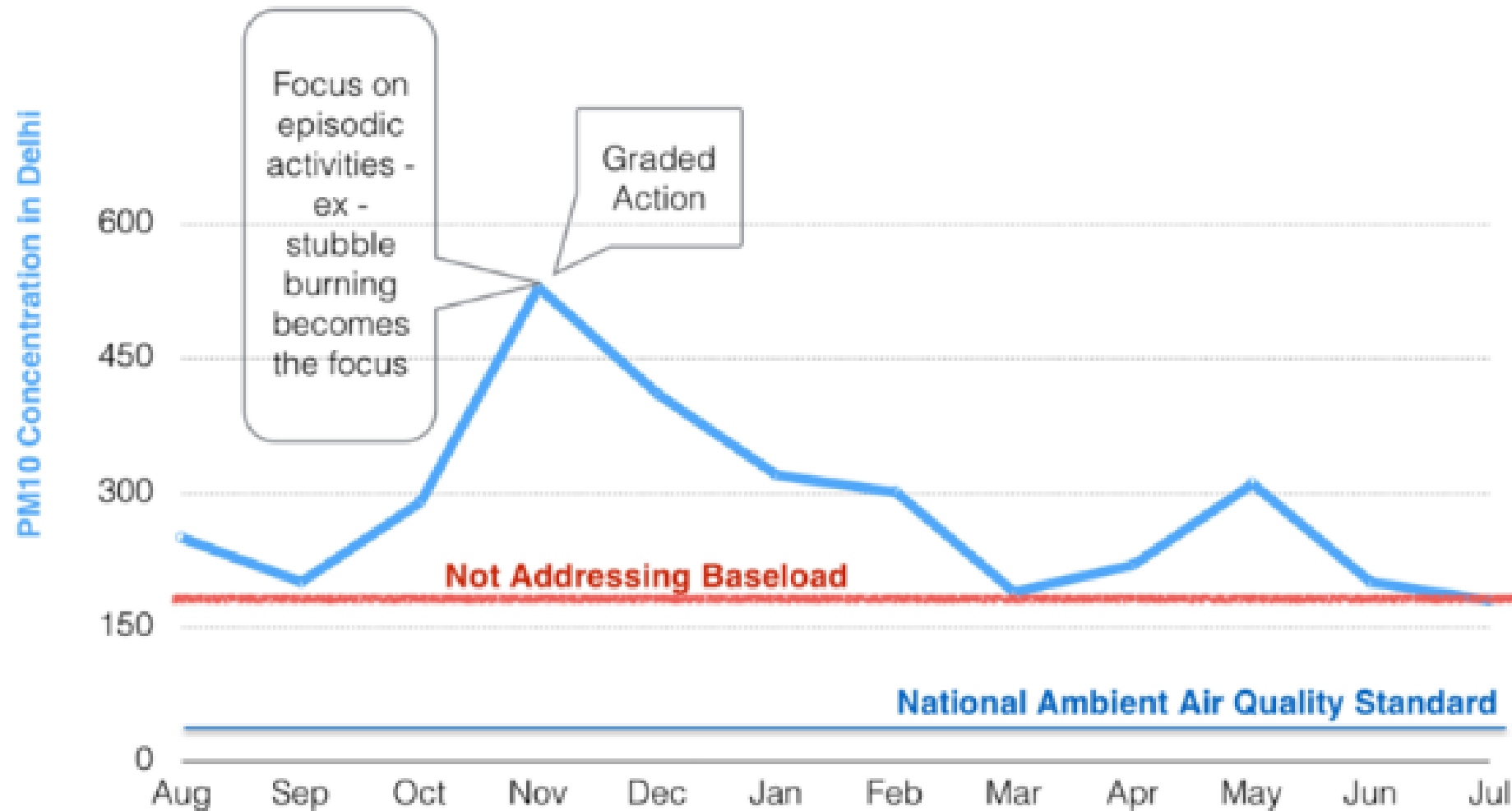
Negative effects

- Nearly all combustion byproducts have negative effects on the environment and human health:
- CO₂ is a greenhouse gas, which contributes to the greenhouse effect.
- SO₂ causes acid rain, which is harmful to plants and to animals that live in water. SO₂ also worsens respiratory illnesses and heart diseases, particularly in children and the elderly.
- NO_x contribute to ground-level ozone, which irritates and damages the lungs.
- PM results in hazy conditions in cities and scenic areas and coupled with ozone, contributes to asthma and chronic bronchitis, especially in children and the elderly. Very small, or *fine PM*, is also believed to cause emphysema and lung cancer.
- Heavy metals such as mercury are hazardous to human and animal health.

Power plants reduce air pollution emissions in various ways

- Burning low-sulfur-content coal to reduce SO₂ emissions.
- Some coal-fired power plants *cofire* wood chips with coal to reduce SO₂ emissions. Pretreating and processing coal can also reduce the level of undesirable compounds in combustion gases.
- Different kinds of particulate emission control devices treat combustion gases before they exit the power plant:
 - *Bag-houses* are large filters that trap particulates.
 - Electrostatic precipitators use electrically charged plates that attract and pull particulates out of the combustion gas.
 - Wet scrubbers use a liquid solution to remove PM from combustion gas.
- Wet and dry scrubbers mix lime in the fuel (coal) or spray a lime solution into combustion gases to reduce SO₂ emissions. [Fluidized bed combustion](#) also results in lower SO₂ emissions.
- NO_x emissions controls include low NO_x burners during the combustion phase or selective catalytic and non-catalytic converters during the post combustion phase.

Changing the focus from 'Peak' to 'Baseload'



Coal power plants release particulate matter

Soot contains particles anywhere from 2.5 to 10 micrometers in diameter.

These have irregular surfaces that allow sulfur dioxide and nitrogen oxides to bind to them.

If it doesn't have a control system, a typical plant can emit as much as **500 tons of particles into the air each year.**

The particles can cause health problems such as asthma, chronic bronchitis, and even premature death.

Mercury is released during coal combustion:

- In general, power plants emit 50 percent of the mercury released into the air, and 75 percent of the acid gases released.
- Mercury vapor is highly toxic, and can easily enter water and be converted by bacteria into a neurotoxin known as methyl mercury, which can cause seizures, cerebral palsy, and even death.

Power plants discharge polluted water:

- Many power plants are placed along bodies of water, where they can draw it in for cooling.
- Billions of gallons may be used daily. The water is then delivered back to the river or sea, creating warm plumes, which can starve aquatic life of oxygen in summer and trap species in ice-free areas during the winter.
- Discharge waters may also contain chlorine and heavy metals.