

GLOBAL ENVIRONMENTAL ISSUES AND AGREEMENTS

Chapter : 04



After completing this chapter, you will be able to

- Explain the causes and consequences of acid rain
- Explain the causes and consequences of ozone layer depletion
- Explain the causes and consequences of global warming
- Evaluate the international responses to acid rain, ozone layer, and climate change
- Analyze the economics of atmospheric pollution and international agreements



Acid Rain

What is Acid Rain?

Acid rain is rain (or any other form of precipitation like snow, fog, or dust) that has a lower pH (more acidic) than normal rainwater.

Normal rain is slightly acidic (pH ~ 5.6) due to dissolved carbon dioxide.

Acid rain has a pH usually between 4.0 and 4.5, caused mainly by sulfur dioxide (SO_2) and nitrogen oxides (NO_x) in the atmosphere.



Acid Rain

Causes of Acid Rain

1. Anthropogenic (Human-made) Causes

- Burning of fossil fuels: Coal-based power plants, oil refineries, and factories release SO_2 and NO_x .
- Vehicle emissions: Cars, trucks, and buses emit NO_x .
- Industrial processes: Smelting of metals, chemical industries, and cement factories.
- Agricultural burning: Crop residue and biomass burning also add pollutants.

Acid Rain

Causes of Acid Rain

2. Natural Causes

- Volcanic eruptions release large amounts of SO_2 .
- Lightning produces NO_x .
- Forest fires release multiple gases, including SO_2 .



Acid Rain

Causes of Acid Rain

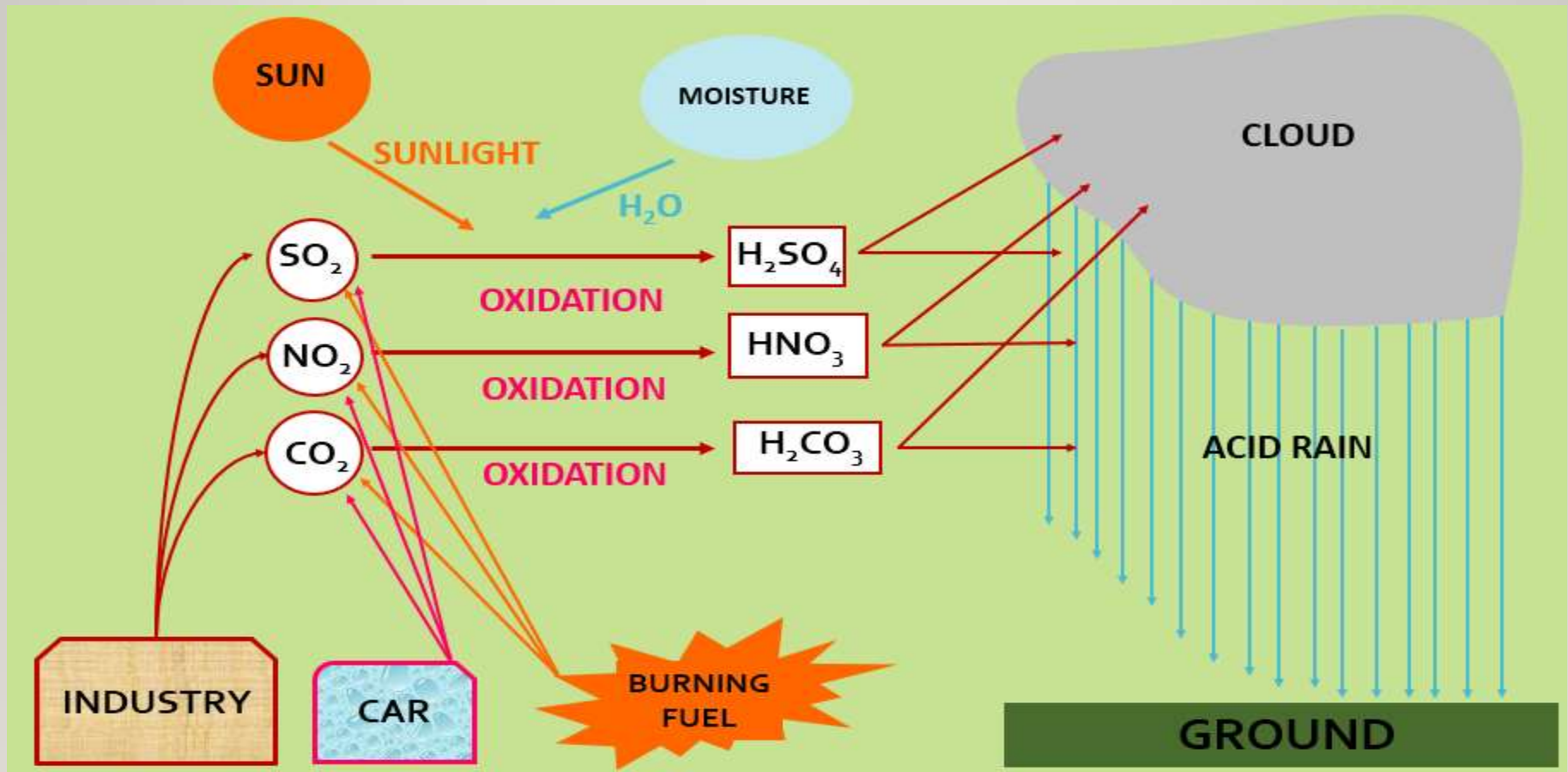
3. Atmospheric Reactions



These acids mix with rainwater → form **acid rain**.

Acid Rain

Atmospheric Reactions



Acid Rain

Consequences of Acid Rain

1. Environmental Impacts

Aquatic life: Acidifies lakes and rivers → fish, amphibians, and plankton die.

Forests: Leaches nutrients (Ca, Mg, K) from soil, damages leaves and tree bark.

Soil: Reduces fertility by increasing acidity and mobilizing toxic metals like aluminum.



Acid Rain

Consequences of Acid Rain

2. Damage to Human Structures

- Corrodes bridges, railways, and vehicles.
- Damages heritage monuments made of limestone and marble (e.g., Taj Mahal, Parthenon).



Acid Rain

Consequences of Acid Rain

3. Human Health

Acid rain itself doesn't burn the skin, but its precursor gases (SO_2 , NO_x):

- Cause **respiratory problems** (asthma, bronchitis, lung irritation).
- Form fine particulate matter (PM2.5) harmful to lungs and heart.

Acid Rain

Consequences of Acid Rain

4. Economic Costs

- Decline in agricultural and fisheries productivity.
- Expensive restoration of cultural monuments and infrastructure.



Acid Rain

Remedies (Prevention and Control)

1. Reducing Emissions

- **Switch to clean energy:** Renewable sources (solar, wind, hydropower, nuclear).
- **Use low-sulfur fuels:** Desulfurization of coal and oil before burning.
- **Install scrubbers:** Flue-gas desulfurization (FGD) in industries to trap SO_2 .
- **Catalytic converters in vehicles:** Reduce NO_x emissions.

Acid Rain

Remedies (Prevention and Control)

2. Policy & Regulation

- Strict air quality standards
- International agreements (e.g., 1979 Geneva Convention on Long-Range Transboundary Air Pollution).
- Enforcement of emission caps.

Acid Rain

Remedies (Prevention and Control)

3. Environmental Restoration

- Liming of lakes and soils: Adding lime (CaCO_3) neutralizes acidity.
- Reforestation: Planting trees that absorb pollutants.
- Restoration of ecosystems harmed by acidification.



Acid Rain

Remedies (Prevention and Control)

4. Public Awareness & Lifestyle Changes

- Promoting **public transport** and reducing car dependency.
- Encouraging energy efficiency and conservation.
- Awareness campaigns about pollution and heritage conservation.

Acid Rain

Conclusion

Acid rain is acidic precipitation caused mainly by SO_2 and NO_x from burning fossil fuels and industrial activity.

It damages aquatic life, forests, soil, monuments, human health, and the economy.

Remedies lie in emission reduction, clean energy adoption, environmental restoration, and strong policy enforcement.



Ozone Layer Depletion

What is the Ozone Layer?

- A thin protective shield of ozone (O₃) molecules located in the stratosphere (10–50 km above Earth).
- It absorbs ~97–99% of harmful ultraviolet (UV-B and UV-C) radiation from the sun.

Ozone Layer Depletion

Causes of Ozone Layer Depletion

1. Human-made (Anthropogenic) Causes

- Chlorofluorocarbons (CFCs): Used in refrigeration, air conditioning, aerosol sprays, and foam-blowing agents.
- Halons: Fire extinguishers.
- Industrial solvents
- Nitrous Oxide (N₂O): From fertilizers, vehicles, and industries.



Ozone Layer Depletion

Causes of Ozone Layer Depletion

2. Natural Causes

- Volcanic eruptions releasing chlorine compounds.
- Natural N₂O emissions from soils and oceans.
- But natural causes are much less significant than human activities.

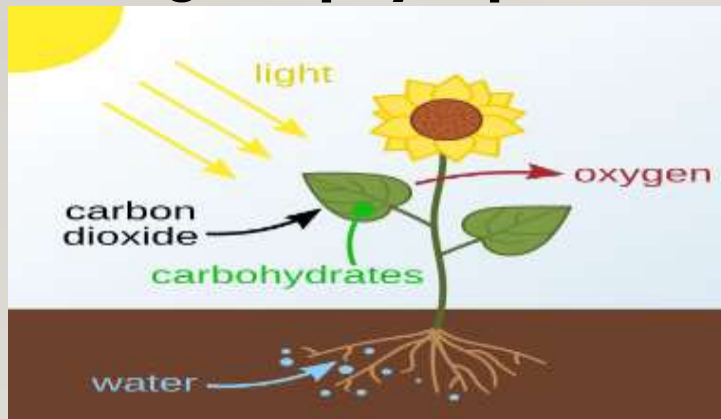


Ozone Layer Depletion

Consequences of Ozone Layer Depletion

1. Environmental Effects

- More **UV radiation** reaches Earth's surface.
- Reduced **photosynthesis** in plants → lower crop yields.
- Damage to **phytoplankton** → affects marine food chains.



Ozone Layer Depletion

Consequences of Ozone Layer Depletion

2. Human Health Effects

- Increased risk of skin cancers (melanoma, carcinoma).
- Eye damage: Cataracts and other eye diseases.
- Immune system suppression: Reduced ability to fight infections.



Ozone Layer Depletion

Remedial Measures (Solutions)

I. Policy & International Agreements

Montreal Protocol (1987): Landmark international treaty to phase out ozone-depleting substances (ODS).

Strengthened by later amendments (London 1990, Copenhagen 1992, Kigali 2016 for HFCs).



Ozone Layer Depletion

Remedial Measures (Solutions)

2. Reducing ODS Use

Replace CFCs, halons, and other ODS with safer alternatives (HFCs, HCFCs, natural refrigerants like ammonia, CO₂).

Promote ozone-friendly technologies in refrigeration, air conditioning, and aerosols.



Ozone Layer Depletion

Remedial Measures (Solutions)

3. Awareness & Legislation

Public awareness campaigns about the harmful effects of ODS.

Enforcing laws to regulate production and consumption of harmful chemicals.



Ozone Layer Depletion

Remedial Measures (Solutions)

4. Research & Monitoring

- Continuous satellite monitoring of ozone levels (e.g., NASA, WMO).
- Research on safe substitutes and better recycling technologies.



Ozone Layer Depletion

Conclusions

Ozone layer depletion is mainly caused by human-made chemicals (CFCs, halons, N_2O) that release chlorine and bromine, destroying ozone molecules.

Its consequences include skin cancer, cataracts, immune suppression, damage to crops, marine ecosystems, and materials.

Remedies include phasing out ODS under the **Montreal Protocol**, adopting eco-friendly substitutes, raising awareness, and global cooperation.



Review of Acid Rain and Ozone Layer

1. Which of the following gases is **not** responsible for acid rain?

- a) CO_2
- b) SO_2
- c) NO_2
- d) Both b and c

Review of Acid Rain and Ozone Layer

2. Normal rainwater has a pH of about —

- a) 4.5
- b) 5.6
- c) 7.0
- d) 2.0



Review of Acid Rain and Ozone Layer

3. Which monument in India has been damaged by acid rain?

- a) Red Fort
- b) Qutub Minar
- c) Taj Mahal
- d) Charminar



Review of Acid Rain and Ozone Layer

4. The main chemical component of acid rain is —

- a) Carbonic acid
- b) Sulfuric acid
- c) Phosphoric acid
- d) Acetic acid

Review of Acid Rain and Ozone Layer

5. The ozone layer is mainly found in which part of the atmosphere?

- a) Troposphere
- b) Stratosphere
- c) Mesosphere
- d) Thermosphere



Review of Acid Rain and Ozone Layer

6. Which type of radiation is mostly absorbed by the ozone layer?

- a) Infrared
- b) Visible light
- c) Ultraviolet (UV)
- d) Radio waves



Review of Acid Rain and Ozone Layer

7. Which of the following substances is the main cause of ozone layer depletion?

- a) Carbon dioxide
- b) Methane
- c) Chlorofluorocarbons (CFCs)
- d) Sulfur dioxide

Review of Acid Rain and Ozone Layer

8. Which of the following is a **natural cause** of ozone depletion?

- a) Use of aerosols
- b) Volcanic eruptions
- c) Refrigeration systems
- d) Air conditioning units

Review of Acid Rain and Ozone Layer

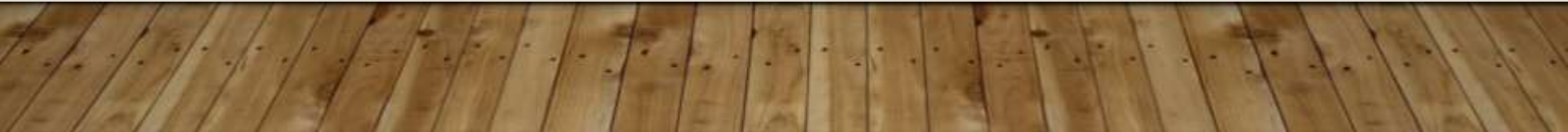
9. Ozone layer depletion allows more UV radiation to reach Earth, causing —

- a) Skin cancer and cataracts
- b) Typhoid and cholera
- c) Asthma and tuberculosis
- d) Diabetes and obesity

Review of Acid Rain and Ozone Layer

10. Increased UV radiation affects plants by —

- a) Boosting photosynthesis
- b) Damaging leaf tissues and reducing yields
- c) Enhancing seed germination
- d) Increasing nitrogen fixation



Review of Acid Rain and Ozone Layer

11. Which marine organisms are most affected by increased UV rays?

- a) Fish
- b) Whales
- c) Phytoplankton
- d) Crabs

Review of Acid Rain and Ozone Layer

12. The **Montreal Protocol (1987)** aims to —

- a) Reduce global warming
- b) Protect biodiversity
- c) Phase out ozone-depleting substances
- d) Control acid rain

Review of Acid Rain and Ozone Layer

13. Which of the following chemicals is a **safe alternative** to CFCs?

- a) Hydrofluorocarbons (HFCs)
- b) Carbon tetrachloride
- c) Halons
- d) Methyl chloroform

Review of Acid Rain and Ozone Layer

14. The international agreement to protect the ozone layer was signed in —

- a) Kyoto, Japan
- b) Montreal, Canada
- c) Paris, France
- d) Geneva, Switzerland

Review of Acid Rain and Ozone Layer

15. Which household practice helps reduce ozone depletion?

- a) Using air fresheners with aerosols
- b) Regular servicing of refrigerators and ACs to prevent gas leakage
- c) Burning plastic waste
- d) Using older model refrigerators

Case Study on Ozone Layer Depletion

The **ozone layer** acts as Earth's natural shield, absorbing most of the harmful ultraviolet (UV-B) radiation from the sun. However, by the late 1970s and early 1980s, scientists detected significant thinning of the ozone layer—especially over Antarctica, known as the “**ozone hole**.”

Research identified that **chlorofluorocarbons (CFCs)** used in **refrigerators, air conditioners, aerosol sprays, and foam production** were the major cause. When released into the atmosphere, these chemicals rise to the stratosphere, where UV rays break them down, releasing chlorine atoms that destroy ozone molecules.

This depletion allowed more UV radiation to reach Earth's surface, leading to **higher rates of skin cancer, eye cataracts, crop damage, and harm to marine ecosystems.**

In response, the **Montreal Protocol (1987)** was signed by over 190 countries to phase out the production and consumption of ozone-depleting substances (ODS). Since then, the ozone layer has shown signs of gradual recovery due to global cooperation and environmental regulation.



Case Study on Ozone Layer Depletion

1. What are the main human activities responsible for ozone layer depletion?
2. Explain how CFCs destroy ozone molecules in the atmosphere.
3. Mention two major health and environmental impacts of ozone layer depletion.
4. What is the significance of the Montreal Protocol (1987)?
5. Suggest two practical measures individuals and governments can take to protect the ozone layer.