

POLLUTIONS & GLOBAL PERSPECTIVES

Ecological and environmental issues

Pollution Terminologies

- **Pollution** refers to an unwanted change in the environment caused by the introduction of harmful materials or the production of harmful conditions (heat, cold, sound) (by human).
- **Contamination** has a meaning similar to that of pollution and implies making something unfit for a particular use through the introduction of undesirable materials (sometimes referred to natural ones)
- **Toxin** refers to substances (pollutants) that are poisonous to living things.
 - **Toxicology** is the science that studies toxins or suspected toxins,
 - **Toxicologists** are scientists in this field.
 - **Carcinogen** is a toxin that increases the risk of cancer.
 - Carcinogens are among the most feared and regulated toxins in our society.

- Pollutants are commonly introduced into the environment by way of
 - **point sources**, into waterways, a small stream such as smokestacks (المداخن), pipes discharging in the ocean, or accidental spills.
 - **nonpoint sources**, area sources, are more diffused over the land and include urban runoff and mobile sources, such as automobile exhaust.
 - Area sources are difficult to isolate and correct because the problem is often widely dispersed over a region, as in agricultural runoff that contains pesticides.
- An important concept in considering pollution problems is **synergism** (التآزر), the interaction of different substances, resulting in a total effect that is greater than the sum of the effects of the separate substances.
 - For example both sulfur dioxide (SO₂) and coal dust particulates are air pollutants.
 - Either one taken separately may cause adverse health effects, but when they combine, as when SO₂ adheres to the coal dust, the dust with SO₂ is inhaled deeper than SO₂ alone and causes greater damage to lungs.
 - Another aspect of synergistic effects is that the body may be more sensitive to a toxin if it is simultaneously subjected to other toxins.

Categories of Pollutants

- Pollution can be referred to man-made production and spreading of waste materials, usually harm to many livings including human being himself.
- Pollutants could be categorized as:
 1. **Environmentally transmitted infectious disease:** Pathogens and microbial
 2. **Inorganic toxic chemicals:** Heavy metals and pharmaceutical drugs ; Acids
 3. **Organic toxic compounds:** Sewage water; pesticides; Nutrients fertilizers
 4. **Nuclear radiation:** Radioactive matters
 5. **Thermal pollution:** Factories; electrical generating station
 6. **Particulates sediments:** Asbestos
 7. **Light and Electromagnetic Fields**
 8. **Noise Pollution**

...etc

10.2 Categories of Pollutants

1) Infectious diseases: spread by the interactions between individuals and by the food, water, air, soil, and animals we come in contact with—constitute some of the oldest health problems that people face

Environmentally Transmitted Infectious Disease

Diseases that can be controlled by manipulating the environment, such as by improving sanitation or treating water, are classified as environmental health concerns. Although there is great concern about the toxins and carcinogens produced in industrial society today, the greatest mortality in developing countries is caused by environmentally transmitted infectious disease. In the United States, thousands of cases of waterborne illness and food poisoning occur each year. These diseases can be spread by people; by mosquitoes and fleas; or by contact with contaminated food, water, or soil. They can also be transmitted through ventilation systems in buildings. The following are some examples of environmentally transmitted infectious diseases:

- Legionellosis, or Legionnaires' disease, which often occurs where air-conditioning systems have been contaminated by disease-causing organisms.
- Giardiasis, a protozoan infection of the small intestine, spread via food, water, or person-to-person contact.
- Salmonella, a food-poisoning bacterial infection that is spread via water or food.
- Malaria, a protozoan infection transmitted by mosquitoes.
- Lyme borreliosis (Lyme disease), transmitted by ticks.
- Cryptosporidiosis, a protozoan infection transmitted via water or person-to-person contact (see Chapter 19).¹⁰
- Anthrax, spread by terrorist activity.

2) Toxic Heavy Metals

- The major **heavy metals** (metals with relatively high atomic weight) that pose health hazards to people and ecosystems include **mercury, lead, cadmium, nickel, gold, platinum, silver, bismuth, arsenic, selenium, vanadium, chromium, and thallium.**
- Each of these elements may be found in soil or water not contaminated by people, each has uses in our modern industrial society, and each is also a by-product of the mining, refining, and use of other elements.
- Heavy metals often have direct physiological toxic effects. Some are stored or incorporated in living tissue, sometimes permanently.
- Heavy metals tend to be stored (accumulating with time) in fatty body tissue.
- A little arsenic each day may eventually result in a fatal dose—the subject of more than one murder mystery.

Toxic Pathways

- Chemical elements released from rocks or human processes can become concentrated in people through many pathways
- These pathways may involve what is known as **biomagnification**: the accumulation or increasing concentration of a substance in living tissue as it moves through a food web (also known as **bioaccumulation**).
 - For example, cadmium, which increases the risk of heart disease, may enter the environment via ash from burning coal.
 - The cadmium in coal is in very low concentrations (less than 0.05 ppm). However, after coal is burned in a power plant, the ash is collected in a solid form and disposed of in a landfill.
 - The landfill is covered with soil and re vegetated.
 - The low concentration of cadmium in the ash and soil is taken into the plants as they grow, but the concentration of cadmium in the plants is three to five times greater than the concentration in the ash.
 - As the cadmium moves through the food chain, it becomes more and more concentrated.

3) Organic Compounds

- **Organic compounds** are carbon compounds produced naturally by living organisms or synthetically by industrial processes.
 - It is difficult to generalize about the environmental and health effects of artificially produced organic compounds because there are so many of them, they have so many uses, and they can produce so many different kinds of effects.
- **Synthetic organic compounds** are used in industrial processes, pest control, pharmaceuticals, and food additives.
 - We have produced over 20 million synthetic chemicals, and new ones are appearing at a rate of about 1 million per year!
 - Most are not produced commercially, but up to 100,000 chemicals are now being used, or have been used in the past.
 - Once used and dispersed in the environment, they may become a hazard for decades or even hundreds of years.

Persistent Organic Pollutants

- Some synthetic compounds are called **persistent organic pollutants, or POPs**.
- Many were first produced decades ago, when their harm to the environment was not known, and they are now banned or restricted

- POPs have several properties that define them:

- They have a carbon-based molecular structure, often containing highly reactive chlorine.
- Most are manufactured by people—that is, they are synthetic chemicals.
- They are persistent in the environment—they do not easily break down in the environment.
- They are polluting and toxic.
- They are soluble in fat and likely to accumulate in living tissue.
- They occur in forms that allow them to be transported by wind, water, and sediments for long distances.

Table 10.1 SELECTED COMMON PERSISTENT ORGANIC POLLUTANTS (POPs)

CHEMICAL	EXAMPLE OF USE
Aldrin ^a	Insecticide
Atrazine ^b	Herbicide
DDT ^a	Insecticide
Dieldrin ^a	Insecticide
Endrin ^c	Insecticide
PCBs ^a	Liquid insulators in electric transformers
Dioxins	By-product of herbicide production

^a Banned in the United States and many other countries.

^b Degrades in the environment. It is persistent when reapplied often.

^c Restricted or banned in many countries.

Source: Data in part from Anne Platt McGinn, "Phasing Out Persistent Organic Pollutants," in Lester R. Brown et al., *State of the World 2000* (New York: Norton, 2000).

Voluntary Exposure to toxic substances

- Voluntary exposure to toxins and potentially harmful chemicals is sometimes referred to as exposure to personal pollutants.
- The most common of these are tobacco, alcohol, and other drugs.
- Use and abuse of these substances have led to a variety of human ills, including death and chronic disease; criminal activity, such as reckless driving and manslaughter; loss of careers; street crime; and the straining of human relations at all levels.

4) Nuclear Radiation

- Nuclear radiation is introduced here as a category of pollution.
- We are concerned about nuclear radiation because excessive exposure is linked to serious health problems, including cancer.

5) Thermal Pollution

- Thermal pollution, also called ***heat pollution***, occurs when heat released into water or air produces undesirable effects.
- Heat pollution can occur as a sudden, acute event or as a long-term, chronic release.
- Sudden heat releases may result from natural events, such as brush or forest fires and volcanic eruptions, or from human activities, such as agricultural burning.

6) Particulates

- **Particulates** here refer to small particles of dust (including soot and asbestos fibers) released into the atmosphere by many natural processes and human activities.
- Modern farming and the burning of oil and coal add considerable amounts of particulates to the atmosphere, as do dust storms, fires, and volcanic eruptions.
- The 1991 eruptions of Mount Pinatubo in the Philippines were the largest volcanic eruptions of the 20th century, explosively hurling huge amounts of volcanic ash, sulfur dioxide, and other volcanic material and gases as high as 30 km into the atmosphere.
- Eruptions can have a significant impact on the global environment and are linked to global climate change and stratospheric ozone depletion
- In addition, many chemical toxins, such as heavy metals, enter the biosphere as particulates.
 - Sometimes, nontoxic particulates link with toxic substances, creating a synergetic threat.

Asbestos

- **Asbestos** is a term for several minerals that take the form of small, elongated particles, or fibers.
- Industrial use of asbestos has contributed to fire prevention and has provided protection from the overheating of materials.
- Asbestos is also used as insulation for a variety of other purposes.
- Unfortunately, however, excessive contact with asbestos has led to asbestosis (a lung disease caused by inhaling asbestos) and to cancer in some industrial workers.
- Experiments with animals have demonstrated that asbestos can cause tumors if the fibers are embedded in lung tissue

7) Electromagnetic Fields

- **Electromagnetic fields (EMFs)** are part of everyday urban life.
- Cell phones, electric motors, electric transmission lines for utilities, and our electrical appliances — toasters, electric blankets, computers, and so forth— all produce magnetic fields.
- There is currently a controversy over whether these fields produce a health risk.

8) Noise Pollution

- **Noise pollution** is unwanted sound. The sensation of loudness is related to the intensity of the energy carried by the sound waves and is measured in decibels (dB).

Table 10.2 EXAMPLES OF SOUND LEVELS

SOUND SOURCE	INTENSITY OF SOUND (dB)	HUMAN PERCEPTION
Threshold of hearing	0	
Rustling of leaf	10	Very quiet
Faint whisper	20	Very quiet
Average home	45	Quiet
Light traffic (30 m away)	55	Quiet
Normal conversation	65	Quiet
Chain saw (15 m away)	80	Moderately loud
Jet aircraft flyover at 300 m	100	Very loud
Rock music concert	110	Very loud
Thunderclap (close)	120	Uncomfortably loud
Jet aircraft takeoff at 100 m	125	Uncomfortably loud
	140	Threshold of pain
Rocket engine (close)	180	Traumatic injury

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Air pollution

Natural

Burning sugarcane fields, Maui, Hawaii — an example of a fugitive source of air pollution



Human-Produced

This steel mill in Beijing, China, is a major source of air pollution



Major air pollutants

• *Particulates; SO_x; CO; NO₂; O₃; HC*

Table 21.1 MAJOR NATURAL AND HUMAN-PRODUCED COMPONENTS OF SELECTED AIR POLLUTANTS

AIR POLLUTANTS	EMISSIONS (% OF TOTAL)		MAJOR SOURCES OF HUMAN-PRODUCED COMPONENTS	PERCENT
	NATURAL	HUMAN-PRODUCED		
Particulates	85	15	Fugitive (mostly dust)	85
			Industrial processes	7
			Combustion of fuels (stationary sources)	8
Sulfur oxides (SO _x)	50	50	Combustion of fuels (stationary sources, mostly coal)	84
			Industrial processes	9
Carbon monoxide (CO)	91	9	Transportation (automobiles)	54
Nitrogen dioxide (NO ₂)		Nearly all	Transportation (mostly automobiles)	37
			Combustion of fuels (stationary sources, mostly natural gas and coal)	38
Ozone (O ₃)	A secondary pollutant derived from reaction with sunlight NO ₂ , and oxygen (O ₂)		Concentration present depends on reaction in lower atmosphere involving hydrocarbons and thus automobile exhaust	
Hydrocarbons (HC)	84	16	Transportation (automobiles)	27
			Industrial processes	7

FIGURE 21.4 Sizes of selected particulates. The shaded area shows the size range that produces the greatest lung damage

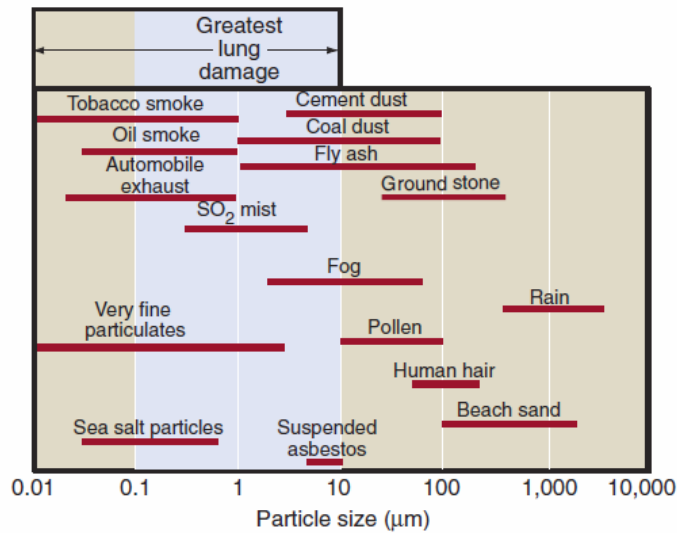
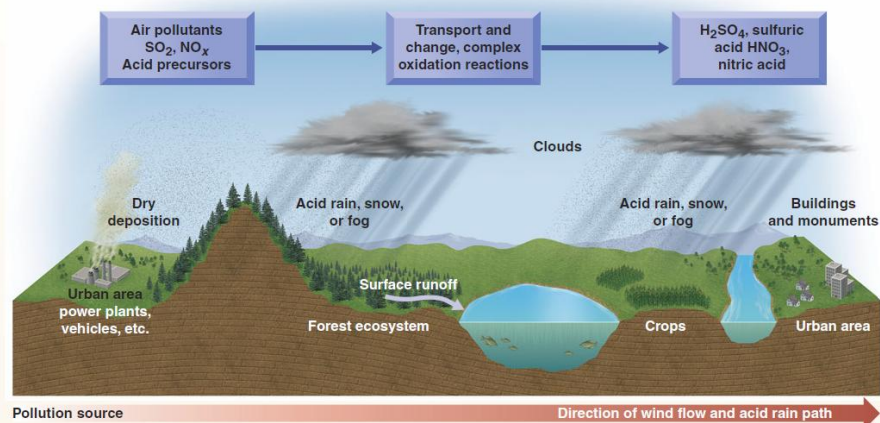
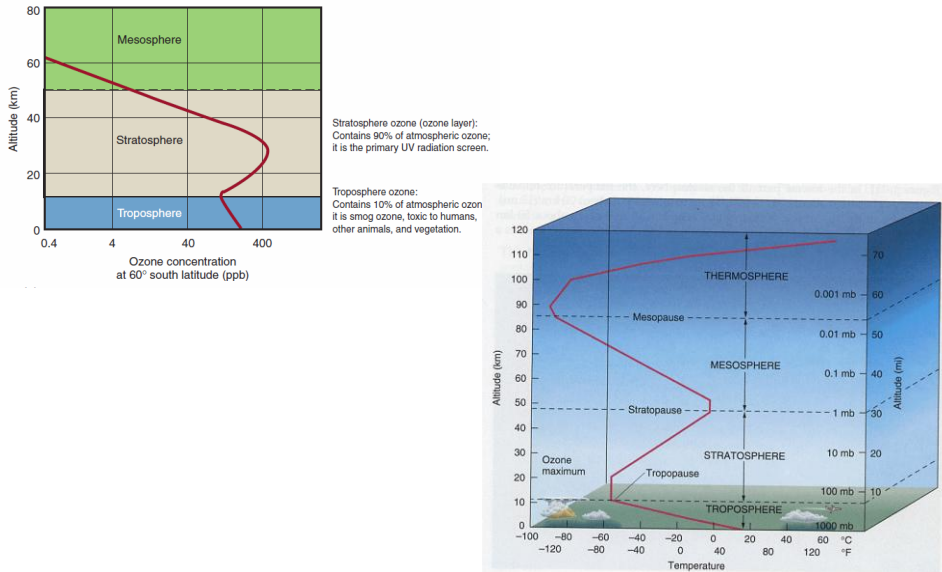


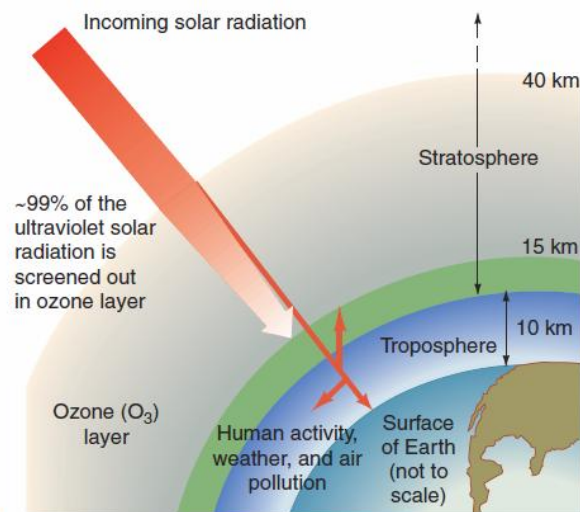
FIGURE 21.6 Idealized diagram showing selected aspects of **Acid Rain formation and paths.**

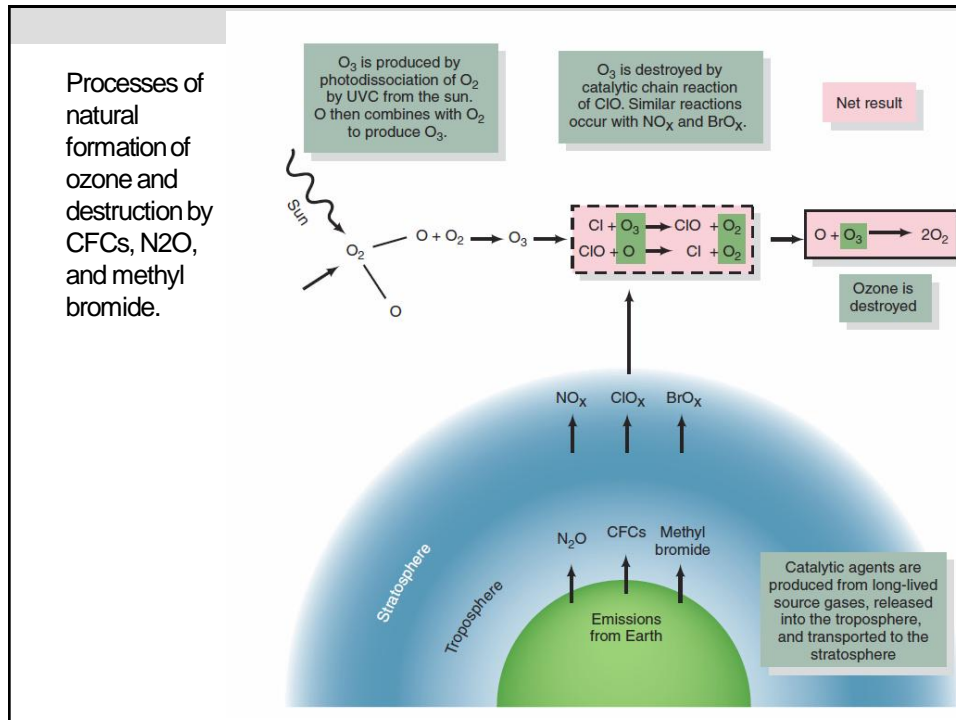


Structure of the atmosphere and Ozone Concentration.



Reduction of the potentially most biologically damaging ultraviolet radiation by ozone in the stratosphere





Greenhouse Gases

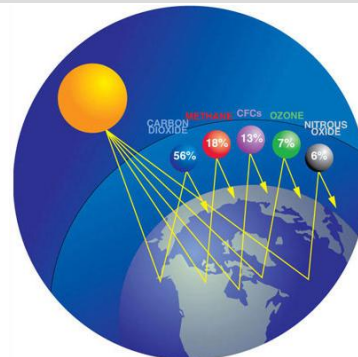


Table 20.1 MAJOR GREENHOUSE GASES

TRACE GASES	RELATIVE CONTRIBUTION (%)	GROWTH RATE (%/YR)
CFC	15 ^a -25 ^b	5
CH ₄	12 ^a -20 ^b	0.4 ^c
O ₃ (troposphere)	8 ^d	0.5
N ₂ O	5 ^d	0.2
Total	40-50	
Contribution of CO ₂	50-60	0.3 ^e -0.5 ^{d,f}

The Atmosphere, Climate, and Global Warming

- Climate models suggest that a doubling of **carbon dioxide concentration** in the atmosphere could raise the mean global temperature 1°–2°C in the next few decades and 1.5°C–4.5°C by the end of this century.
- Many complex positive feedback and negative feedback cycles affect the atmosphere. Natural cycles, solar forcing, aerosol forcing, particulate forcing from volcanic eruptions, and El Niño events also affect the temperature of Earth.
- There are concerns based on scientific evidence that global warming is leading to changes in climate patterns, rise in sea level, melting of glaciers, and changes in the biosphere.
- A potential threat from future warming, as in the Medieval Warm Period, is the occurrence of prolonged drought that would compromise our food supply.
- Adjusting to global warming includes learning to live with the changes and attempting to mitigate warming by reducing emissions of greenhouse gases.

A GLOBAL PERSPECTIVE

Two new ideas profoundly affected our approach to environmental issues

- **One idea-Human:** These atmospheric changes suggest that the actions of many groups of people, at many locations, affect the environment of the entire world
 - Modern civilization is believed to change the environment at a global level.
 - Scientists now believe that emissions of modern chemicals are changing the ozone layer high in the atmosphere.
 - Scientists also believe that burning fossil fuels increases the concentration of greenhouse gases in the atmosphere, which may change Earth's climate.
- **Another idea-Nonhuman:** is that not only human life but also nonhuman life affects the environment of our whole planet and has changed it over the course of several billion years.

Two new ideas profoundly affected our approach to environmental issues

- Awareness of the global interactions between life and the environment has led to the development of the **Gaia hypothesis**.
 - Originated by British chemist *James Lovelock* and American biologist *Lynn Margulis*
- According to the Gaia hypothesis, "***Earth and all living things form a single system with interdependent parts, communication among these parts, and the ability to self-regulate***"
 - It proposes that over the history of life on Earth, life has profoundly changed the global environment, and that these changes have tended to improve the chances for the continuation of life.
 - Because life affects the environment at a global level, the environment of our planet is different from that of a lifeless one.

- **Gaia Theory** is a compelling new way of understanding life on our planet.
 - The theory asserts that living organisms and their inorganic surroundings have evolved together as a single living system that greatly affects the chemistry and conditions of Earth's surface