

Chapter 12 Air - Section 1

E.Q. What Causes Air Pollution?

SEV3. Students will describe stability and change in ecosystems.

- a. Describe interconnections between abiotic and biotic factors, including normal cyclic fluctuations and changes associated with climatic change (i.e. ice ages).

SEV5. Students will recognize that human beings are part of the global ecosystem and will evaluate the effects of human activities and technology on ecosystems.

- e. Describe the effects and potential implications of pollution and resource depletion on the environment at the local and global levels (e.g. air and water pollution, solid waste disposal, depletion of the stratospheric ozone, global warming, and land uses).

Objectives

- Name five primary air pollutants, and give sources for each.
- Name the two major sources of air pollution in urban areas.
- Describe the way in which smog forms.
- Explain the way in which a thermal inversion traps air pollution.

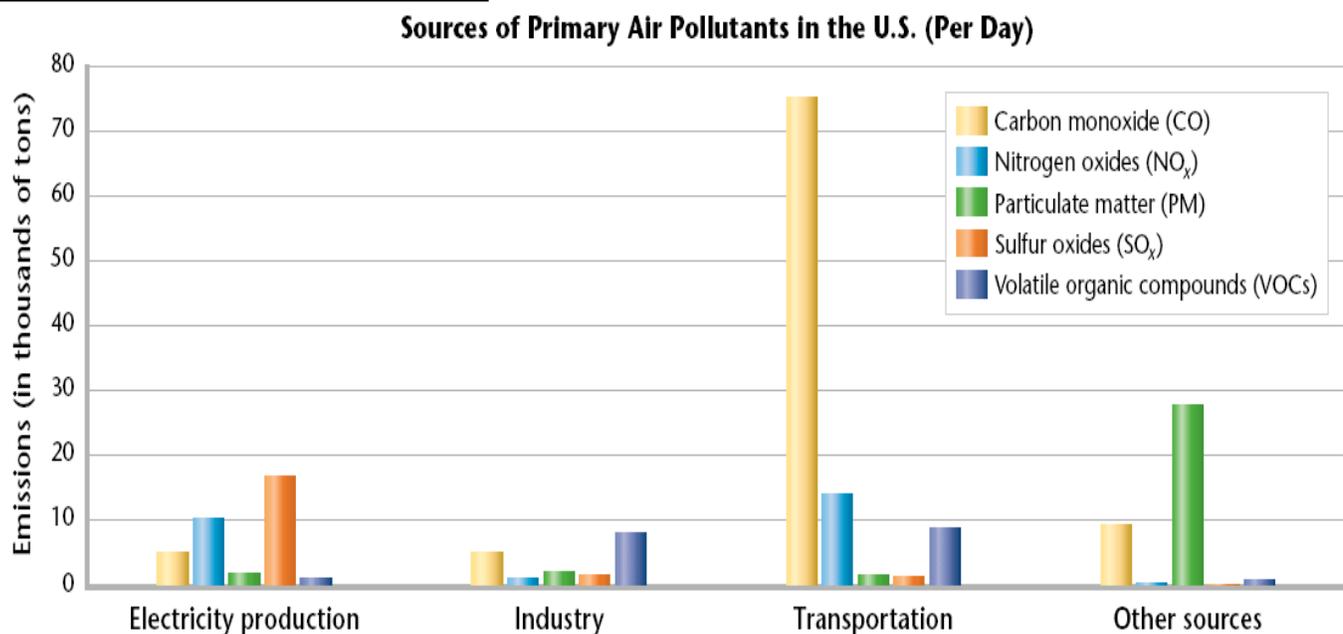
What Causes Air Pollution?

- Air pollution is the contamination of the atmosphere by wastes from sources such as industrial burning and automobile exhausts.
- Substances that pollute the air can be in the form of solids, liquids, or gases.
- Most air pollution is the result of human activities, but some pollutants are natural, including dust, pollen, spores, and sulfur dioxide from volcanic eruptions.

Primary and Secondary Pollutants

- **A primary pollutant is a pollutant that is put directly into the atmosphere by human or natural activity. An example would be soot from smoke.**
- **A secondary pollutant is a pollutant that forms in the atmosphere by chemical reactions with primary air pollutants, natural components in the air, or both. An example would be ground-level ozone.**
- **Ground level ozone forms when the emission from cars react with the UV rays of the sun and then mix with the oxygen in the atmosphere.**

Primary Pollutants



Source: U.S. Environmental Protection Agency.

Sources of Primary Air Pollutants

- **Household products, power plants, and motor vehicles are sources of primary pollutants such as carbon monoxide, nitrogen oxide, sulfur dioxide,**

and chemicals called **volatile organic compounds (VOCs)**.

- **Vehicles and coal-burning power plants are the major sources of nitrogen oxide emissions. Power plants, refineries, and metal smelters contribute much of the sulfur dioxide emissions. Vehicles and gas stations make up most of the human-made emissions of VOCs.**
- **Particulate matter can also pollute the air and is usually divided into fine and coarse particles.**
- **Fine particles enter the air from fuel burned by vehicles and coal-burning power plants.**
- **Sources of course particles are cement plants, mining operations, incinerators, wood-burning fireplaces, fields, and roads.**

Sources of Primary Air Pollutants

Primary Air Pollutants			
Pollutant	Description	Primary Sources	Effects
Carbon monoxide (CO)	CO is an odorless, colorless, poisonous gas. It is produced by the incomplete burning of fossil fuels.	Sources of CO are cars, trucks, buses, small engines, and some industrial processes.	CO interferes with the blood's ability to carry oxygen, slowing reflexes and causing drowsiness. In high concentrations, CO can cause death.
Nitrogen oxides (NO _x)	When combustion (burning) temperatures exceed 538°C, nitrogen and oxygen combine to form nitrogen oxides.	NO _x comes from burning fuels in vehicles, power plants, and industrial boilers.	NO _x can make the body vulnerable to respiratory infections, lung diseases, and cancer. NO _x contributes to the brownish haze seen over cities and to acid precipitation.
Sulfur dioxide (SO ₂)	SO ₂ is produced by chemical interactions between sulfur and oxygen.	SO ₂ comes mostly from burning fossil fuels.	SO ₂ contributes to acid precipitation as sulfuric acid. Secondary pollutants that result from reactions with SO ₂ can harm plant life and irritate the respiratory systems of humans.
Volatile organic compounds (VOCs)	VOCs are organic chemicals that vaporize readily and form toxic fumes.	VOCs come from burning fuels. Vehicles are a major source of VOCs.	VOCs contribute to smog formation and can cause serious health problems, such as cancer. They may also harm plants.
Particulate matter (particulates or PM)	Particulates are tiny particles of liquid or solid matter.	Most particulates come from construction, agriculture, forestry, and fires. Vehicles and industrial processes also contribute particulates.	Particulates can form clouds that reduce visibility and cause a variety of respiratory problems. Particulates have also been linked to cancer. They may also corrode metals and erode buildings and sculptures.

The History of Air Pollution

- **Air pollution is not a new phenomenon. Whenever something burns, pollutants enter the air. In 1273, King Edward I ordered that burning a particularly dirty kind of coal called sea-coal was illegal.**
- **The world's air quality problem is much worse today because modern industrial societies burn large amounts of fossil fuels.**
- **Most air pollution in urban areas comes from vehicles and industry.**

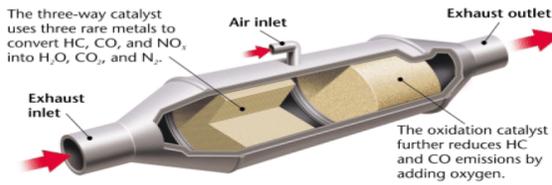
Motor Vehicle Emissions

- **Almost one-third of our air pollution comes from gasoline burned by vehicles.**
- **According to the U.S. Department of Transportation, Americans drove their vehicles over 2.6 trillion miles in 1998.**
- **Over 90 percent of that mileage was driven by passenger vehicles. The rest was driven by trucks and buses.**

Controlling Vehicle Emissions

- **The Clean Air Act, passed in 1970 and strengthened in 1990, gives the Environmental Protection Agency (EPA) the authority to regulate vehicle emissions in the United States.**
- **The EPA required the gradual elimination of lead in gasoline, decreasing lead pollution by more than 90 percent in the United States.**

- **In addition, catalytic converters, required in all automobiles, clean exhaust gases of pollutants before pollutants are able to exit the tail pipe.**



Interior

- ▶ Car seats may be covered in plastic that contains a volatile organic compound called *vinyl chloride*.
- ▶ Each time an air conditioner is installed in a car, 1.1 kg (2.5 lb) of chlorofluorocarbons (CFCs) are released into the air. Each time an air conditioner is recharged, 0.5 kg (1 lb) of CFCs are released.

Body and Frame

- ▶ Steel smelters send thousands of metric tons of sulfur dioxide into the air each year.
- ▶ Many auto factories in Mexico, Eastern Europe, and some Asian countries lack pollution-control devices.

Fuel Tank

- ▶ When filling the car with gasoline, VOCs escape into the atmosphere.

Exhaust

- ▶ Car exhaust is a major source of nitrogen oxides, carbon monoxide, and hydrocarbons.
- ▶ In developing countries, car exhaust may contain over a thousand poisonous substances.
- ▶ Each car releases 4.5 metric tons (5 tons) of carbon dioxide every year.



California Zero-Emission Vehicle Program

- **In 1990, the California Air Resources Board established the zero-emission vehicle (ZEV) program.**
- **Zero-emission vehicles are vehicles that have no tailpipe emissions, no emissions from gasoline, and no emission-control systems that deteriorate over time.**
- **By 2016, 16 percent of all vehicles sold in California are required to be zero-emission vehicles, including SUVs and trucks.**
- **Currently, ZEVs such as electric vehicles are for sale in California, and vehicles with advanced batteries are being demonstrated.**
- **Vehicles powered by hydrogen fuel are being developed and will qualify as ZEVs.**

- **Partial zero-emission vehicles, including hybrid-electric cars, are also included in the program. ZEV programs have also been adopted by Maine, Massachusetts, New York, and Vermont.**

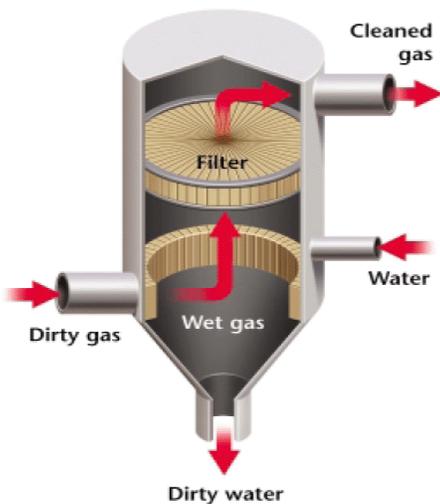
Industrial Air Pollution

- **Many industries and power plants that generate our electricity must burn fuel, usually fossil fuel, to get the energy they need.**
- **Burning fossil fuels releases huge quantities of sulfur dioxide and nitrogen oxide into the air.**
- **Power plants that produce electricity emit at least two-thirds of all sulfur dioxide and more than one-third of all nitrogen oxides that pollute the air.**
- **Some industries also produce VOCs, which are chemical compounds that form toxic fumes.**
- **Dry cleaning, oil refineries, chemical manufacturing plants, furniture refinishers, and automobile repair shops all contribute to the VOCs in the air.**
- **When people use some of the products that contain VOCs, even more VOCs are added to the air.**

Regulating Air Pollution From Industry

- **The Clean Air Act requires many industries to use scrubbers or other pollution-control devices.**

- **Scrubbers remove some of the more harmful substances that would otherwise pollute the air.**
- **A scrubber is a machine that moves gases through a spray of water that dissolves many pollutants. Ammonia is an example of a pollutant gas that can be removed from the air by a scrubber.**



- **Electrostatic precipitators are machines used in cement factories and coal-burning power plants to remove dust particles from smokestacks.**
- **In an electrostatic precipitator, gas containing dust particles is blown through a chamber containing an electrical current.**
- **An electric charge is transferred to the dust particles, causing them to stick together and to the sides of the chamber.**
- **The clean gas is released from the chamber and the concentrated dust particles can then be collected and removed.**

- **Electrostatic precipitators remove 20 million tons of ash generated by coal-burning power plants from the air each year in the United States.**

Smog

- **Smog is urban air pollution composed of a mixture of smoke and fog produced from industrial pollutants and burning fuels.**
- **Smog results from chemical reactions that involve sunlight, air, automobile exhaust, and ozone.**
- **Pollutants released by vehicles and industries are the main causes of smog.**



Temperature Inversions

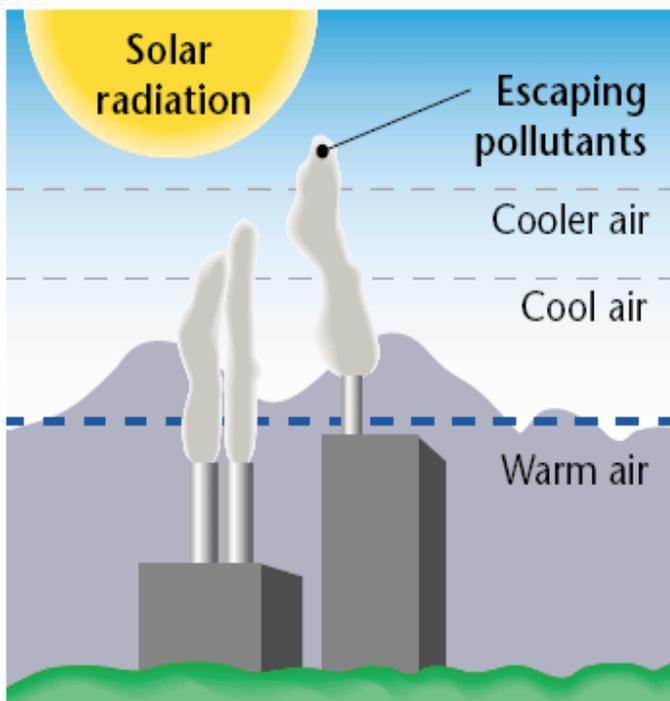
- **The circulation of air in the atmosphere usually keeps air pollution from reaching dangerous levels.**
- **During the day, the sun heats the surface of the Earth and the air near the Earth. The warm air rises through the cooler air above it and carries**

pollutants away from the ground, and into the atmosphere.

- **Sometimes, however, pollution is trapped near the Earth's surface by a temperature inversion.**
- **A temperature inversion is the atmospheric condition in which warm air traps cooler air near Earth's surface.**
- **The warmer air above keeps the cooler air at the surface from moving upward. So, pollutants are trapped below with the cooler air.**
- **If a city is located in a valley, it has a greater chance of experiencing temperature inversions. Los Angeles, surrounded on three sides by mountains, often has temperature inversions**

Temperature Inversions

Normal situation



Temperature inversion

