Chapter 19  Air Pollution

Major Classes of Air Pollutants

- Particulate Material
- Nitrogen Oxides
- Sulfur Oxides
- Carbon Oxides
- Hydrocarbons
- Ozone

Particulate Material

- Tiny particles (solid or liquid) suspended in air
  - Includes: soil particles, ash, lead, asbestos, sea salt, sulfuric acid droplets, etc.
  - May contain toxic materials
  - Small particles become lodged in lungs
Smog

- **Photochemical Smog (ex: Los Angeles)**
  - Brownish-orange haze formed by chemical reactions involving sunlight, nitrogen oxide, and hydrocarbons

Smog: Nitrogen and Sulfur Oxides

- **Nitrogen Oxides (NOx)**
  - Gases produced by atmospheric nitrogen and oxygen at high temperatures

- **Sulfur Oxides (SOx)**
  - Gases produced by chemical interactions between sulfur and oxygen
  - Also causes acid rain

Smog: Carbon Oxides

- **Gases: Carbon Monoxide (CO) and Carbon dioxide (CO2)**
- **Greenhouse gases**
  - Contribute to climate change

- **Human Sources: Transportation, Industry and Livestock**
Sources of Outdoor Air Pollution
- Two main sources
  - Transportation
  - Industry
- Intentional forest fires are also a significant source

Health Effects of Air Pollution
- Low level exposure
  - Irritates eyes
  - Causes inflammation of respiratory tract
  - Can develop into chronic respiratory diseases

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Source</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate</td>
<td>Industries, electric power plants, motor vehicles, construction, agriculture</td>
<td>Aggregate respiratory illness; long term exposure may cause increased incidence of chronic conditions such as bronchitis</td>
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<tr>
<td>Nitrogen oxides</td>
<td>Motor vehicles, industries, heavily fuelled farmstead</td>
<td>Initiate respiratory tract: aggregate respiratory conditions such as asthma and chronic bronchitis</td>
</tr>
<tr>
<td>Sulfur oxides</td>
<td>Electric power plants and other industries</td>
<td>Initiate respiratory tract: same effects as particulates</td>
</tr>
<tr>
<td>Ozone</td>
<td>Formed in atmosphere (secondary air pollutant)</td>
<td>Reduces blood's ability to transport oxygen; headache and fatigue at lower levels; mental impairment or death at high levels</td>
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</tbody>
</table>

Controlling Air Pollution
- Smokestacks with electrostatic precipitator

[Diagram of electrostatic precipitator: Electrode (negative charge), Precipitator wall (positive charge), Dirty gas (reduced in) Dust falls off wall into reflector]
Controlling Air Pollution

- Smokestacks with scrubbers

Coal-fired power plant with mostly water vapor exhaust

Controlling Air Pollution

- Vapor Recovery System for gasoline

The Clean Air Act (1970)

- Authorizes EPA to set limits on amount of specific air pollutants permitted
- Focuses on 6 pollutants:
  - lead, particulate matter, sulfur dioxide, carbon monoxide, nitrogen oxides, and ozone
- Act has led to clear improvements
The Clean Air Act

Experience with the Clean Air Act since 1970 has shown that protecting public health and building the economy can go hand in hand.

Urban Air Quality

<table>
<thead>
<tr>
<th>Table 20.3</th>
<th>U.S. Urban Areas with the Worst Air Quality in 1999 (Ozone Nonattainment Areas), and Conditions in the Same Locations in 2009.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1999</td>
</tr>
<tr>
<td>Los Angeles South Coast Air Basin, California</td>
<td>Extreme</td>
</tr>
<tr>
<td>Chicago, Gary and Lake County, Illinois-Indiana</td>
<td>Very severe</td>
</tr>
<tr>
<td>Houston, Galveston, and Brazoria, Texas</td>
<td>Very severe</td>
</tr>
<tr>
<td>Milwaukee and Racine, Wisconsin</td>
<td>Very severe</td>
</tr>
<tr>
<td>New York City, northern New Jersey, and Long Island, New York-New Jersey-Connecticut</td>
<td>Very severe</td>
</tr>
<tr>
<td>Baltimore, Maryland</td>
<td>Severe</td>
</tr>
<tr>
<td>Philadelphia, Wilmington, Trenton, Pennsylvania-New Jersey-Delaware-Maryland</td>
<td>Severe</td>
</tr>
<tr>
<td>Sacramento, California</td>
<td>Severe</td>
</tr>
<tr>
<td>San Joaquin Valley, California</td>
<td>Severe</td>
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<tr>
<td>Ventura County (between Santa Barbara and Los Angeles), California</td>
<td>Severe</td>
</tr>
</tbody>
</table>
Air Pollution Around the World

- Air quality is poor and becoming worse in many developing countries

- 5 worst cities in world
  - Beijing, China
  - Mexico City, Mexico
  - Shanghai, China
  - Tehran, Iran
  - Calcutta, India

Transporting Air Pollutantion

1. Long-distance atmospheric transport occurs in part because evaporation exceeds deposition onto the land and ocean at low latitudes.

2. More deposition at high latitudes

3. Some chemicals move to higher latitudes by repeatedly evaporating and settling ("jumpfrogging"), sometimes taking several decades before being permanently deposited.

4. The more volatile the chemical, the farther it travels before being deposited onto the land and ocean.