

Environmental Science

Chapter 12: AIR

Holt 2008

What Causes Air Pollution?

- **Air pollution** is the contamination of the atmosphere by wastes from sources such as industrial burning and automobile exhausts.



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.

Primary 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).



Primary Pollutants

- 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 coarse particles are cement plants, mining operations, incinerators, wood-burning fireplaces, fields, and roads.

Motor Vehicle Emissions

- Almost one-third of our air pollution comes from gasoline burned by vehicles.

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 and catalytic converters in all automobiles

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.

Zero-Emission Vehicles

- 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 fuels, to get the energy they need.
- Burning fossil fuels releases huge quantities of sulfur dioxide and nitrogen oxide into the air.

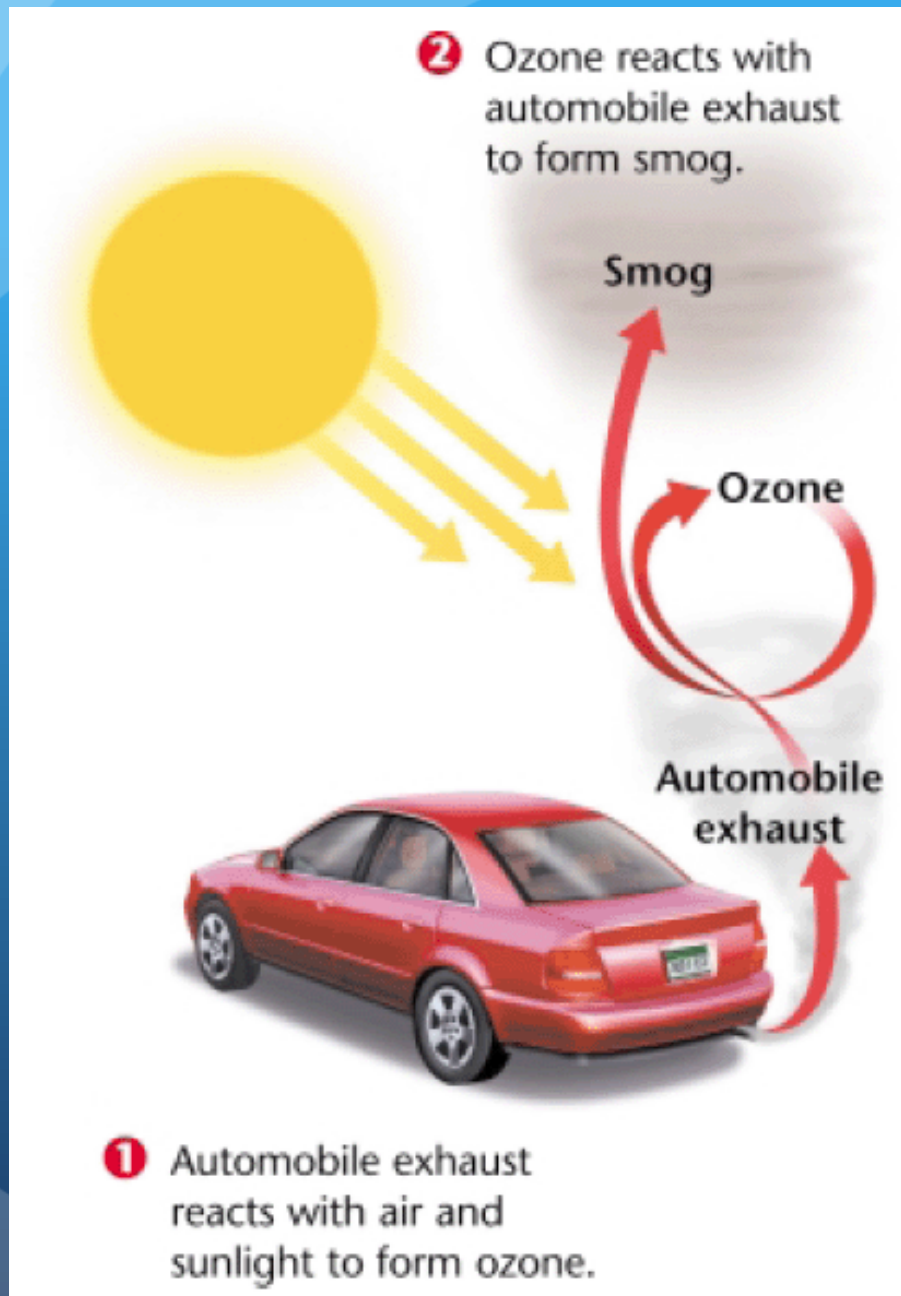
Regulating Air Pollution From Industry

- 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.

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.
- <https://www.youtube.com/watch?v=hYwRNzDYKml>

Formation of Smog



Denver, Colorado- Smog



Los Angeles, California- Smog



Beijing, China - Smog



China Smog



London, England- Smog

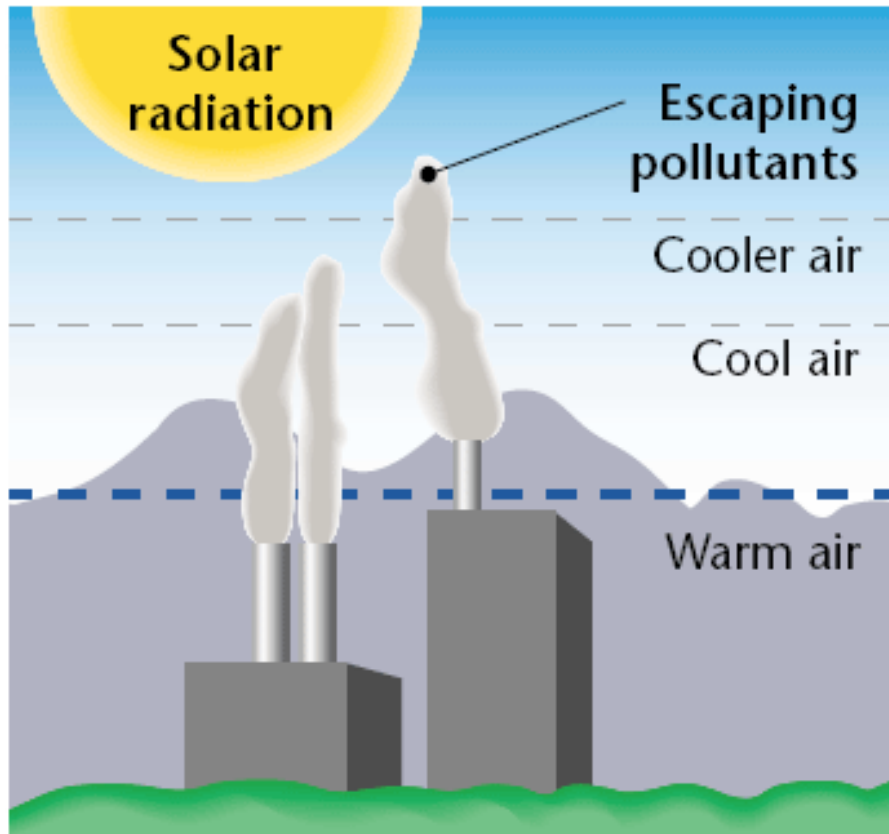


Temperature Inversion

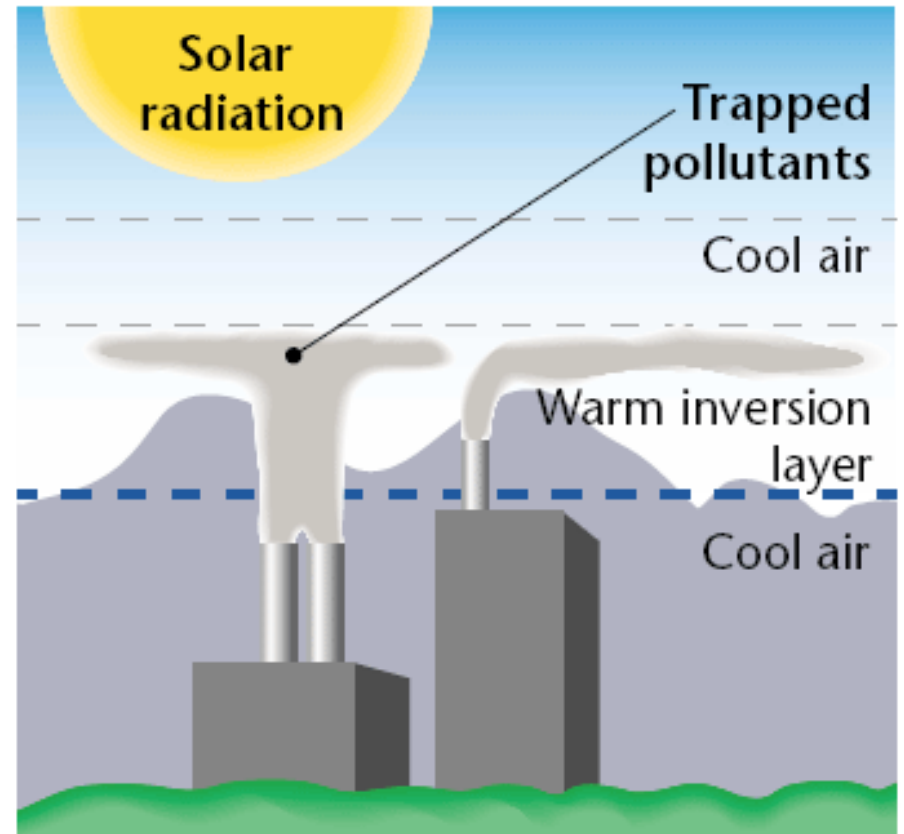
- A **temperature Inversion** is the atmospheric condition in which warm air traps cooler air near Earth's surface.
- The warmer air above keeps the cooler air at the surface from moving upward. So, pollutants are trapped below with the cooler air.
- If a city is located in a valley, it has a greater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

Temperature Inversion

Normal situation



Temperature inversion



Section 2

Air Pollution

- Air pollution can cause serious health problems, especially for people who are very young, very old, or who have heart or lung problems.
- The American Lung Association has estimated that Americans pay tens of billions of dollars a year in health costs to treat respiratory diseases caused by air pollution.

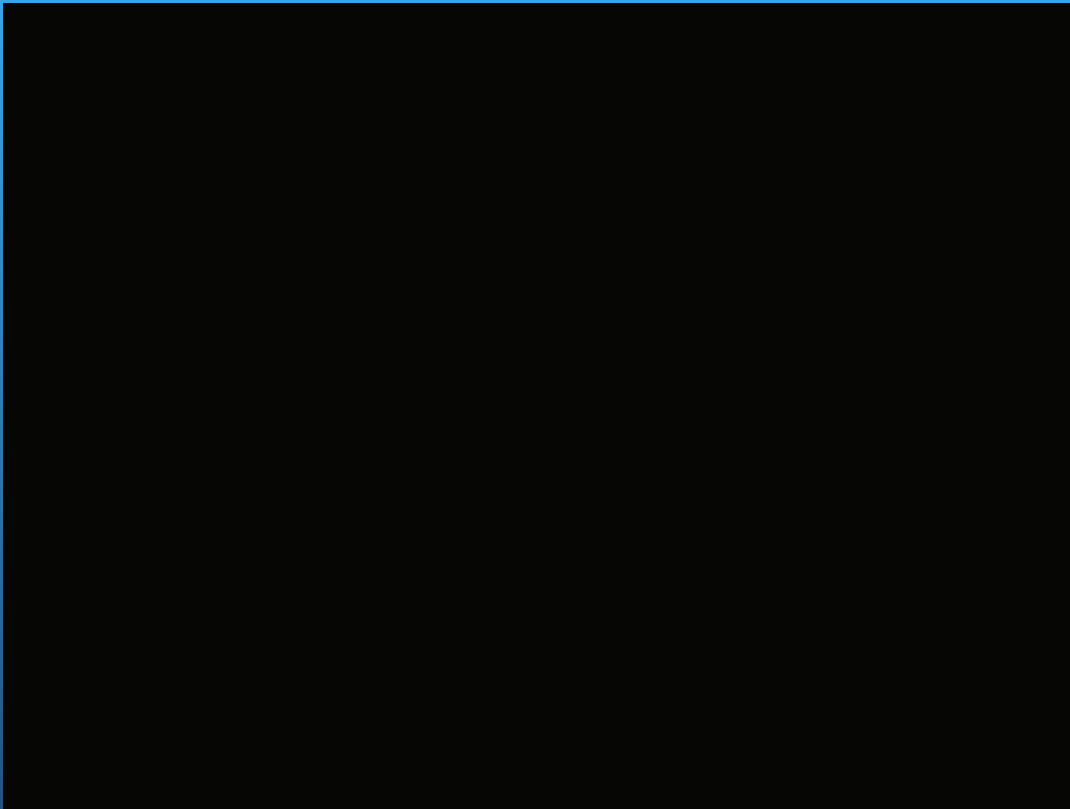
Short-Term Health Effects of Air Pollution

- Many of the effects of air pollution on people's health are short-term and reversible if their exposure to air pollution decreases.
- The short-term effects of air pollution on people's health include headache; nausea; irritation to the eyes, nose and throat; coughing; tightness in the chest; and upper respiratory infections, such as bronchitis and pneumonia.

Long-Term Health Effects of Air Pollution

- Long-term effects on health that have been linked to air pollution include emphysema, lung cancer, and heart disease.
- Long-term exposure to air pollution may worsen medical conditions suffered by older people and may damage the lungs of children.

Studying the Effects of Air Pollution



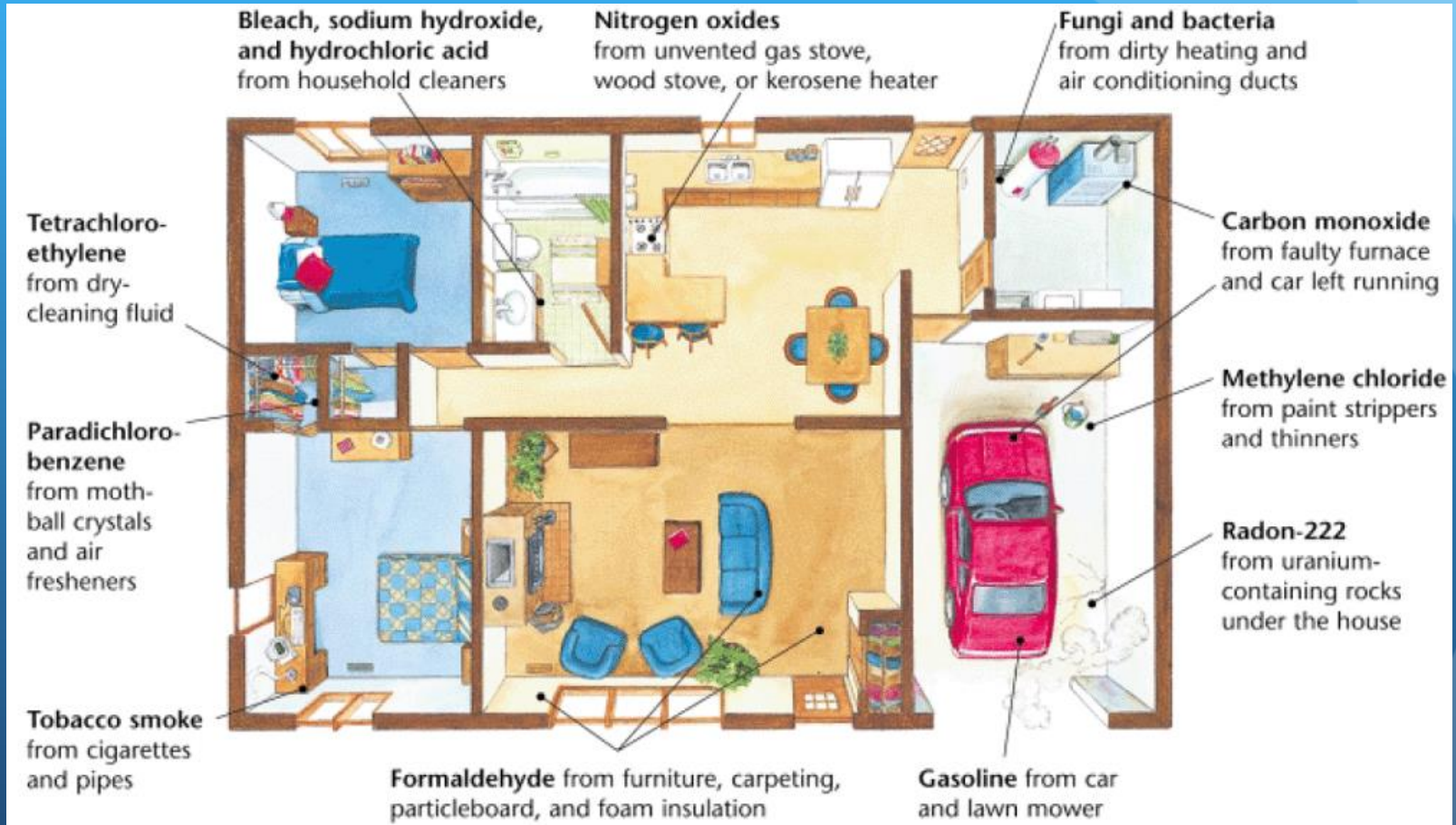
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Intelecom. (2001). Studying the Effects of Air Pollution [Video Segment].
Available from <http://www.discoveryeducation.com/>

Indoor Air Pollution

- The quality of air inside a home or building is sometimes worse than the quality of air outside.
- Plastics and other industrial chemicals are major sources of pollution.
- These compounds can be found in carpets, building materials, paints, and furniture, particularly when these items are new.

Indoor Air Pollution



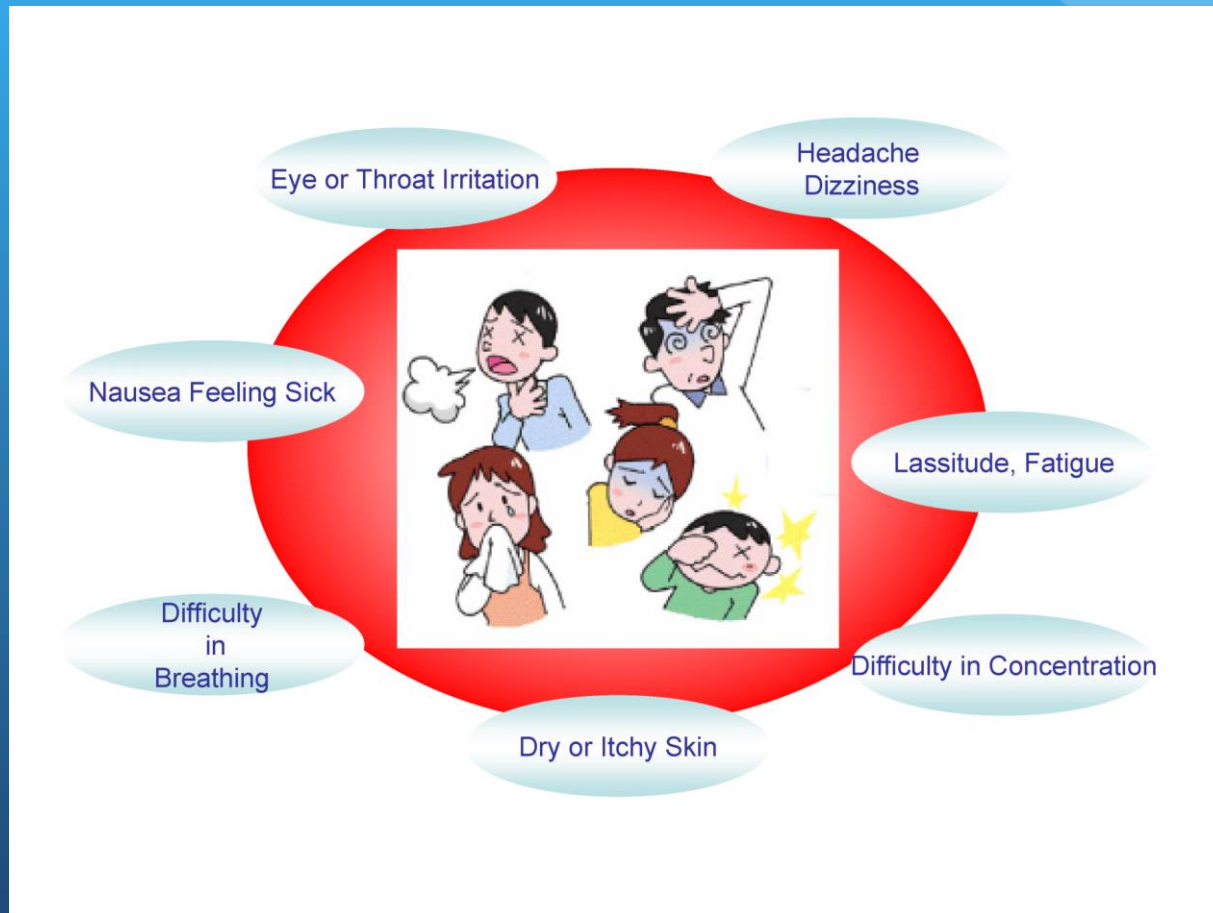
Indoor Air Pollution

- **Sick-building syndrome** is a set of symptoms, such as headache, fatigue, eye irritation, and dizziness, that may affect workers in modern, airtight office buildings.
- Sick-building syndrome is believed to be caused by indoor air pollutants.
- Sick-building syndrome is most common in hot places where buildings are tightly sealed to keep out the heat.

Indoor Air Pollution

- Identifying and removing the sources of indoor air pollution is the most effective way to maintain good indoor quality.
- Ventilation, or mixing outdoor air with indoor air, is also necessary for good air quality.
- When activities such as renovation and painting, which cause indoor air pollution, are undertaken, ventilation should be increased.

Sick Building Syndrome



Plants Remove toxins from Indoor Air



Radon Gas

- Radon gas is colorless, tasteless, odorless, and radioactive.
- Radon is one of the elements produced by the decay of uranium, a radioactive element that occurs naturally in the Earth's crust.
- Radon can seep through cracks and holes in foundations into homes, offices, and schools, where it adheres to dust particles.

Radon Gas

- When people inhale the dust, radon enters their lungs. In the lungs, radon can destroy the genetic material in cells that line the air passages.
- Such damage can lead to cancer, especially among people who smoke.
- Radon is the second-leading cause of lung cancer in the United States.

Radon Gas



Radon Test Kits



Polk County Radon Levels

35% of homes 0-2 pCi/L

18% of homes 2-3.9 pCi/L

47% of homes +4 pCi/L

Asbestos

- **Asbestos** is any of six silicate minerals that form bundles of minute fibers that are heat resistant, flexible, and durable.
- Asbestos is primarily used as an insulator and as a fire retardant, and it was used extensively in building materials.
- However, for all of its uses, the government banned the use of most asbestos products in the early 1970s.

Asbestos

- That was because exposure to asbestos in the air is very dangerous.
- Asbestos fibers can cut and scar the lungs, causing the disease asbestosis.
- Victims of the disease have more and more difficulty breathing and may eventually die of heart failure.

Asbestos Fibers



Noise Pollution

- A sound of any kind is called a noise. However, some noises are unnecessary and can cause noise pollution.
- Health problems that can be caused by noise pollution include loss of hearing, high blood pressure, and stress.
- Noise can also cause loss of sleep, which may lead to decreased productivity at work and in the classroom.

Noise Pollution

- A **decibel** is the most common unit used to measure loudness, and is abbreviated dB.
- The quietest sound that a human ear can hear is represented by 0 dB. For each increase in decibel intensity, the decibel level is 10 times higher than the previous level.
- A sound of 120 dB is at the threshold of pain. Permanent deafness may come as a result of continuous exposure to sounds over 120 dB.

Noise Pollution

Intensity of Common Noises	
Noise	Intensity (dB)
Rocket engine	180
Jet engine	140
Rock-and-roll concert	120
Car horn	110
Chainsaw	100
Lawnmower	90
Doorbell	80
Conversation	60
Whisper	30
Faintest sound heard by the human ear	0



Light Pollution

- Light pollution does not present a direct hazard to human health, but it does negatively affect our environment.
- The use of inefficient lighting in urban areas is diminishing our view of the night sky.
- In urban areas, the sky is often much brighter than the natural sky.

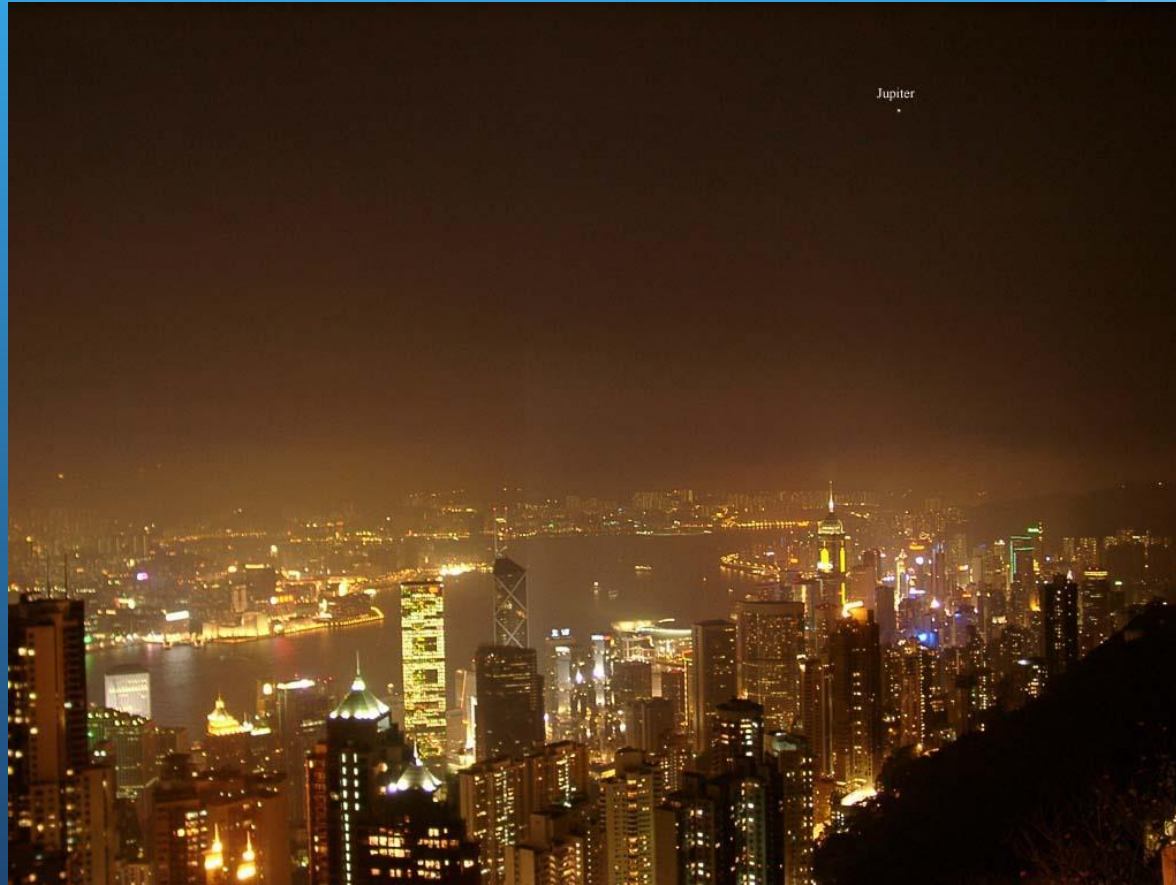
Light Pollution

- A more important environmental concern of inefficient lighting is energy waste. Energy is wasted when a light is directed upward into the night sky and lost to space. Examples include lighting on billboards, poor-quality street lights, and the lighting of building exteriors.
- Solutions to this problem include shielding light so it is directed downward, using time controls so that light is used only when needed, and using low-pressure sodium sources, which are the most energy-efficient sources of light.

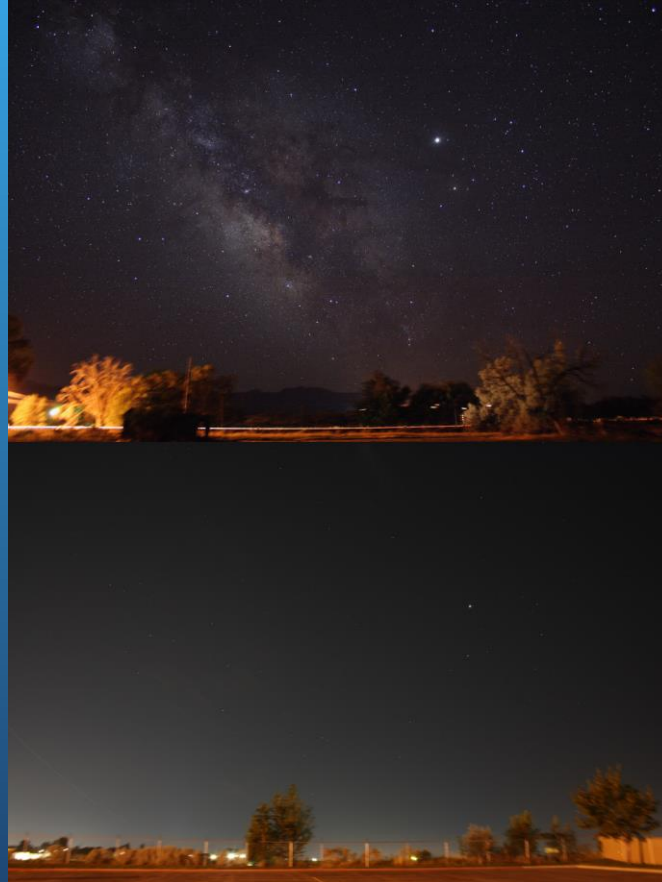
Light Pollution

- 2002- the Czech republic outlawed the use of excessive outdoor lighting.
- If every American home replaced just one standard bulb with a CF bulb, it would save enough energy to light more than 3 million homes for a year.

City Light Pollution



Light Pollution: Country vs. City



US Light Pollution



World Light Pollution



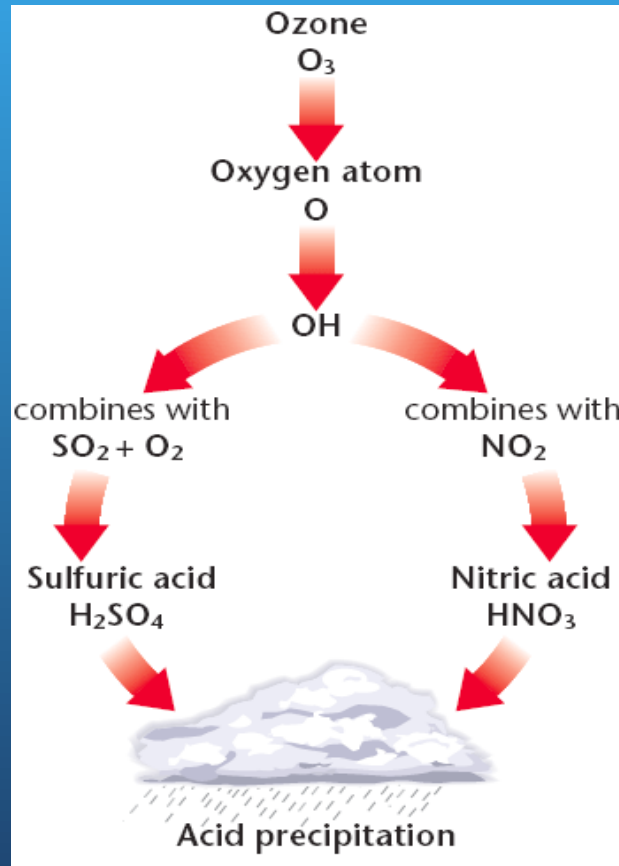
Japanese Street Lighting



What Causes Acid Precipitation?

- **Acid Precipitation** is precipitation, such as rain, sleet, or snow, that contains a high concentration of acids, often because of the pollution of the atmosphere.
- When fossil fuels are burned, they release oxides of sulfur and nitrogen.
- When these oxides combine with water in the atmosphere they form sulfuric acid and nitric acid, which falls as acid precipitation.

What Causes Acid Precipitation?



What Causes Acid Precipitation?

- This acidic water flows over and through the ground, and into lakes, rivers, and streams.
- Acid precipitation can kill living things, and can result in the decline or loss of some local animal and plant populations.

Acid Rain Damage



Statues damaged by acid rain



Acid Rain Effects



Acid Rain



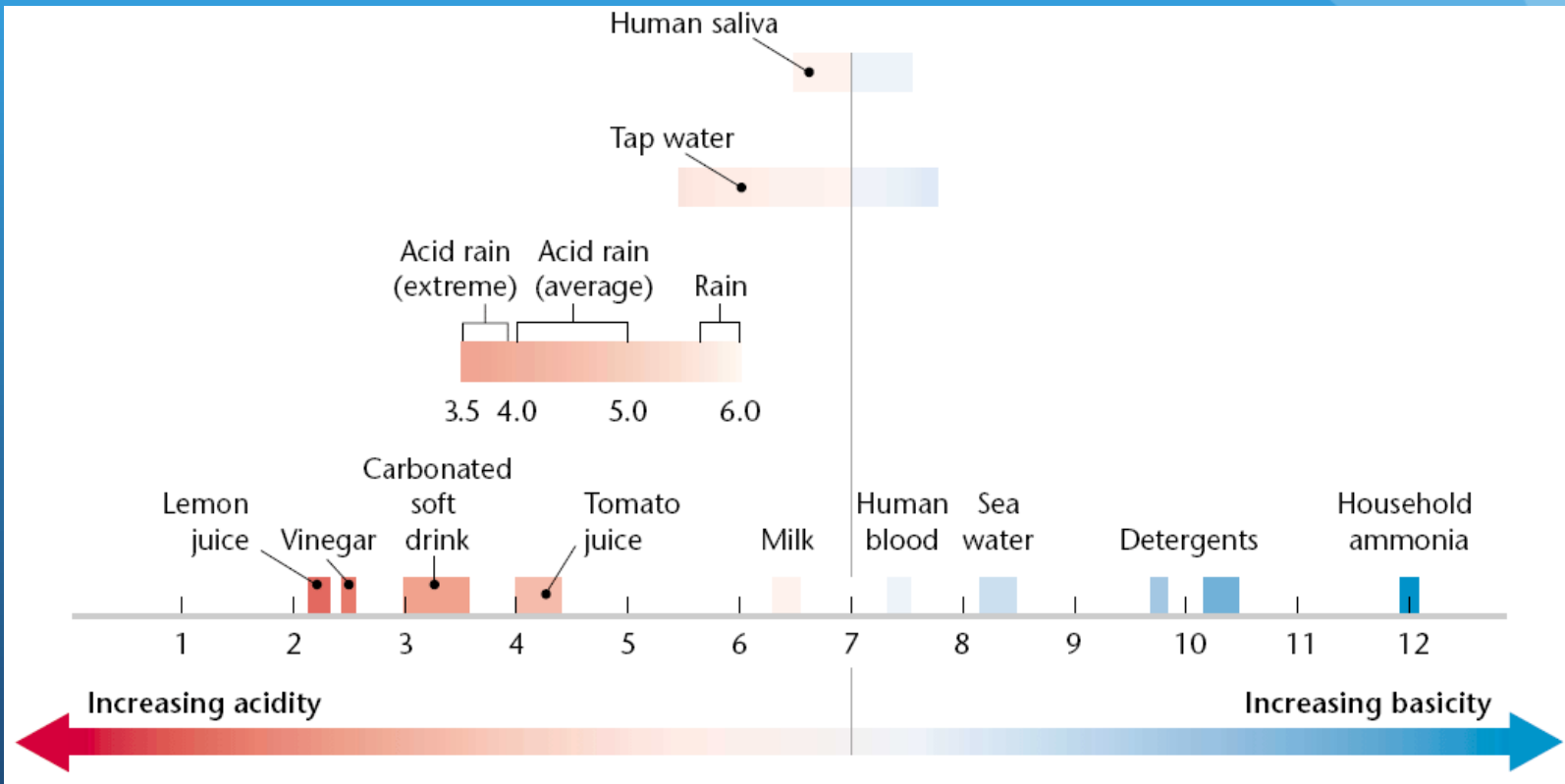


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What Causes Acid Rain Precipitation?

- A **pH** number is a value that is used to express the acidity or alkalinity (basicity) of a system.
- Each whole number on the scale indicates a tenfold change in acidity.
- A pH of 7 is neutral, a pH of less than 7 is acidic, and a pH of greater than 7 is basic.
- Pure water has a pH of 7.0, while normal precipitation has a pH of about 5.6.

Acid Precipitation- pH Scale



What Causes Acid Precipitation?

- Normal precipitation is slightly acidic because atmospheric carbon dioxide dissolves into the precipitation and forms carbonic acid.
- Precipitation is considered acid precipitation if it has a pH of less than 5.0
- The pH of precipitation varies among different geographic areas. The pH of precipitation in the eastern U.S. and Canada ranges from 4.2 to 4.8, with the most acidic precipitation occurring around Lake Erie and Lake Ontario.

How Acid Precipitation Affects Soils and Plants

- Acid precipitation can cause a drop in the pH of soil and water. This increase in the concentration of acid is called **acidification**.
- When the acidity of soil increases, some nutrients are dissolved and washed away by rainwater. It also causes aluminum and other toxic metals to be released and possibly absorbed by the roots of plants causing root damage.
- Sulfur dioxide in water vapor clogs the openings on the surfaces of plants.

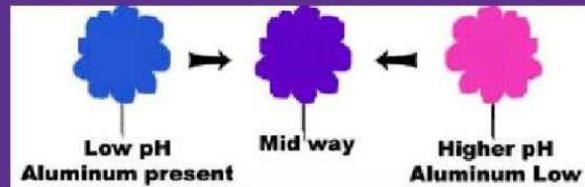
Hydrangea Plants

Purple Hydrangeas

If you've ever seen a deep purple hydrangea, it probably took your breath away. To me they are the most beautiful of all colors and also the most difficult to obtain.

I have always been curious about how a person could make a purple hydrangea or, if it were purchased purple, how one could keep it that way. Here are a few things I've learned:

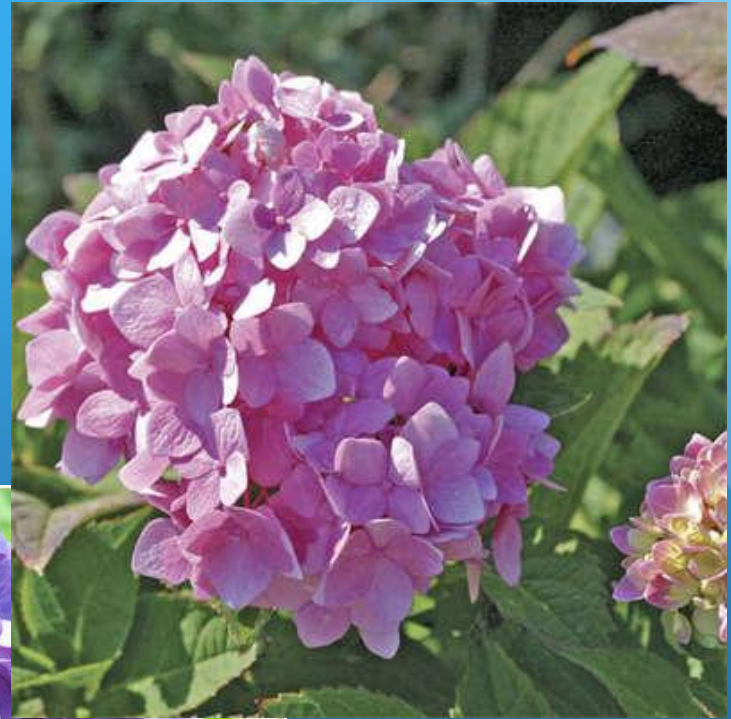
Like any hydrangea, the color depends on the makeup of the soil. The soil conditions for purple are right in the middle of pink and blue.



In addition, only a deep pink (almost red) or a deep, vibrant blue hydrangea has a chance of becoming deep purple. Light pink and light blue hydrangeas will become lavender under the same soil conditions. Many varieties such as 'Merritt's Beauty,' 'Masja,' and 'Gentian Dome,' would be good subjects to try.



Jocelyn Williamson, ©2008 HGIC, Clemson Extension



Acid Precipitation and Aquatic Ecosystems

- Aquatic animals are adapted to live in an environment with a particular pH range. If acid precipitation falls on a lake and changes the water's pH, it can kill aquatic plants and animals.
- In addition, acid precipitation causes aluminum to leach out of the soil surrounding a lake. The aluminum accumulates in the gills of fish and interferes with oxygen and salt exchange. As a result, fish are slowly suffocated.

Acid Shock

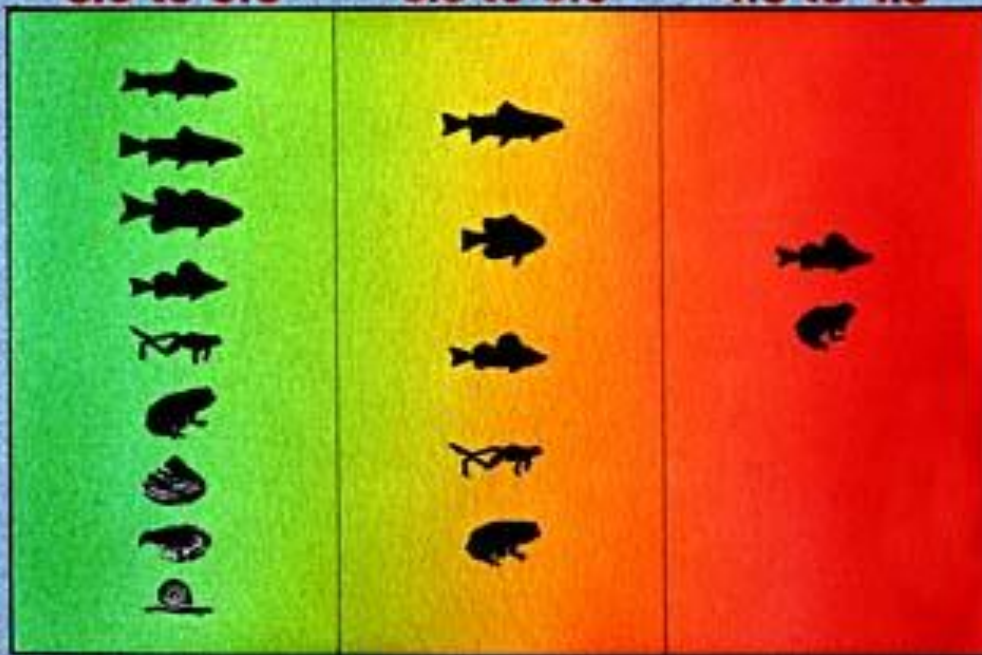
- **Acid shock** is the sudden runoff of large amounts of highly acidic water into lakes and streams when snow melts in the spring or when heavy rains follow a drought.
- This phenomenon causes large numbers of fish to die, and affects the reproduction of fish and amphibians that remain. They produce fewer eggs, and those eggs often do not hatch. The offspring that do survive often have birth defects and cannot reproduce.

pH OF WATER

6.5 to 6.0

5.5 to 5.0

4.5 to 4.0





**ACID
RAIN**

BURNS MY

BASS!

Fish Kill due to Acid Rain



Deformed Frogs



- To counteract the effects of acid precipitation on aquatic ecosystems, some states in the U.S. and some countries spray powdered limestone (calcium carbonate) on acidified lakes in the spring to help them restore their natural pH.
- Because lime has a pH that is basic, the lime raises the pH of the water.
- Unfortunately, enough lime cannot be spread to offset all acid damage to lakes.

Neutralizing a Lake with Lime



Acid Precipitation and Humans

- Toxic metals such as aluminum and mercury can be released into the environment when soil acidity increases. These toxic metals can find their way into crops, water, and fish. The toxins then poison the human body.
- Research has also indicated that there may be a correlation between large amounts of acid precipitation received and an increase in respiratory problems in a community's children.

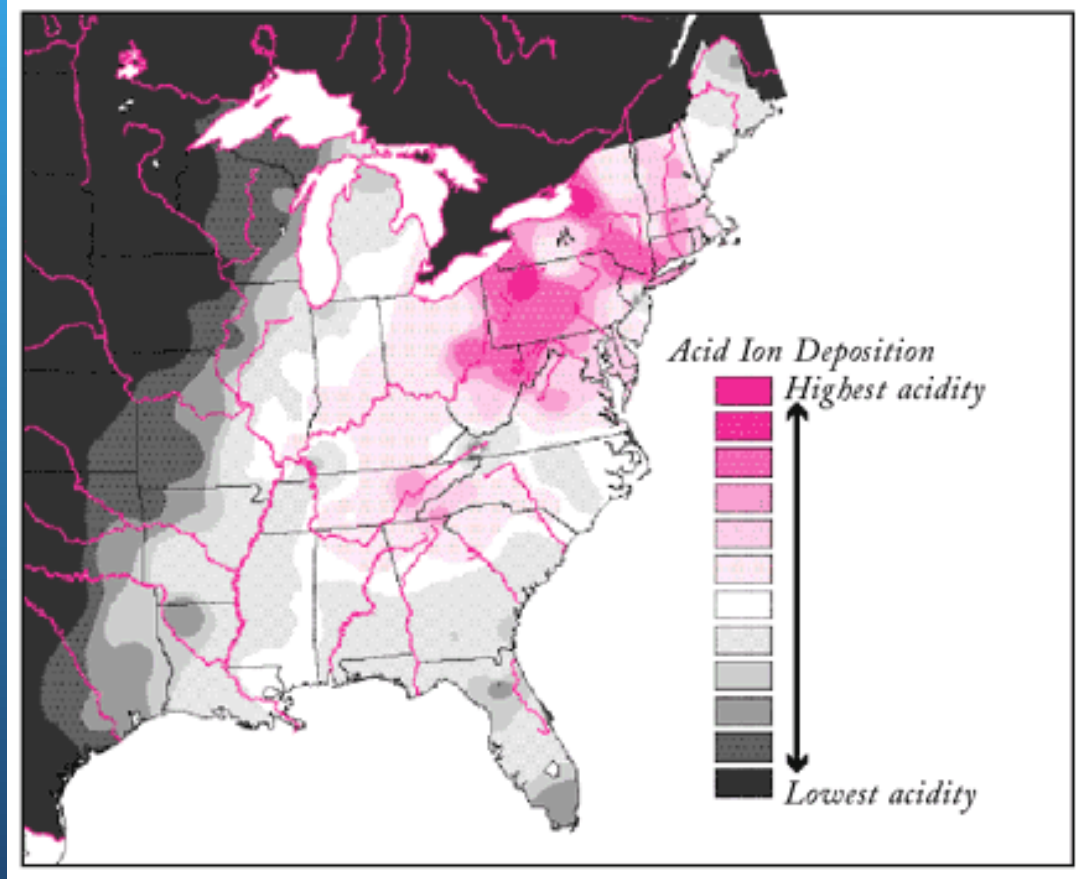
Acid Precipitation and Humans

- The standard of living for some people is affected by acid precipitation. Decreases in numbers of fish caused by acidification of lakes can influence the livelihood of commercial fishermen and the sport-fishing industry. Forestry is also affected when trees are damaged by acid precipitation.
- Acid precipitation can dissolve the calcium carbonate in common building materials, such as concrete. As a result, some of the worlds most important and historic monuments, including those made of marble are being affected.

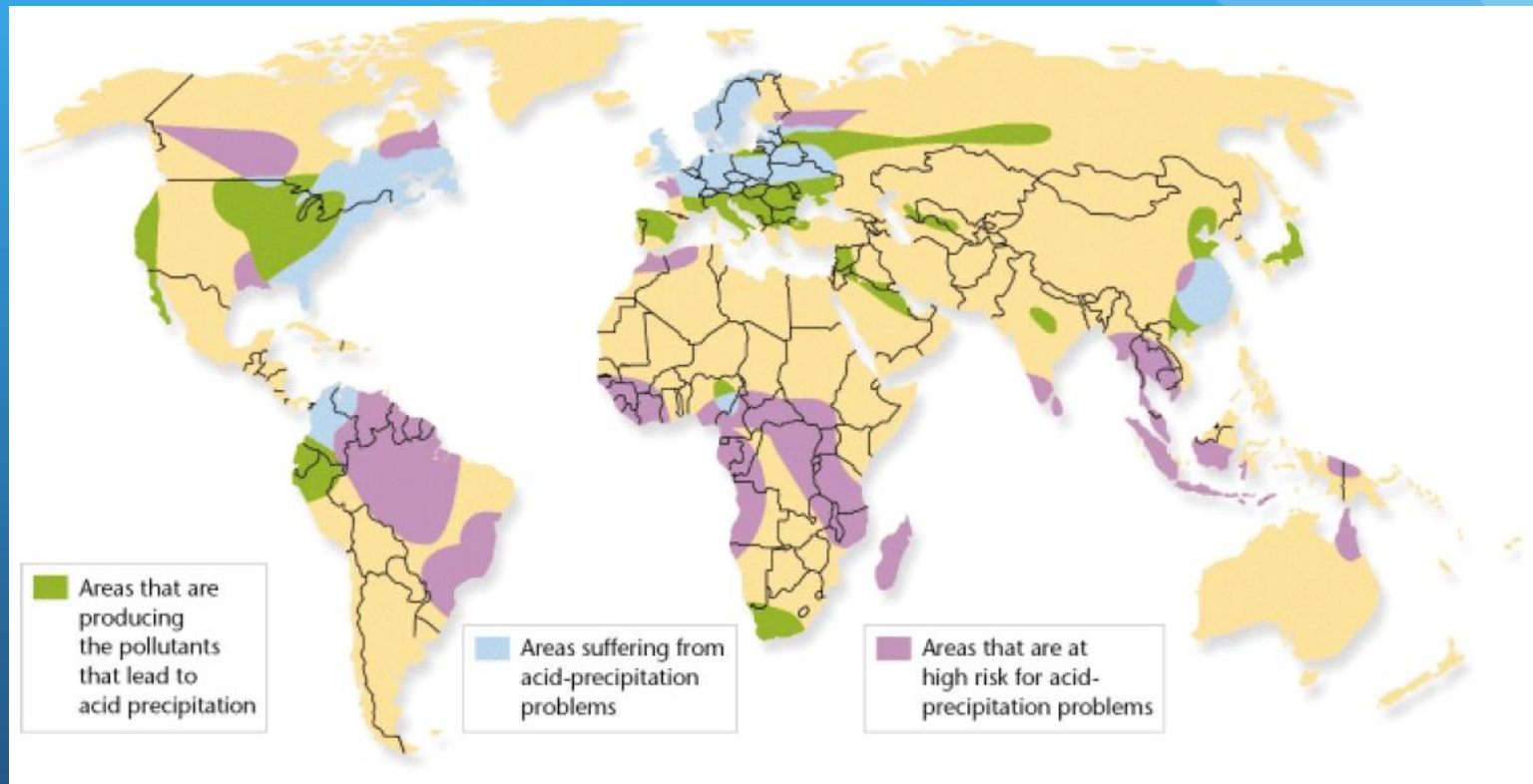
International Conflict

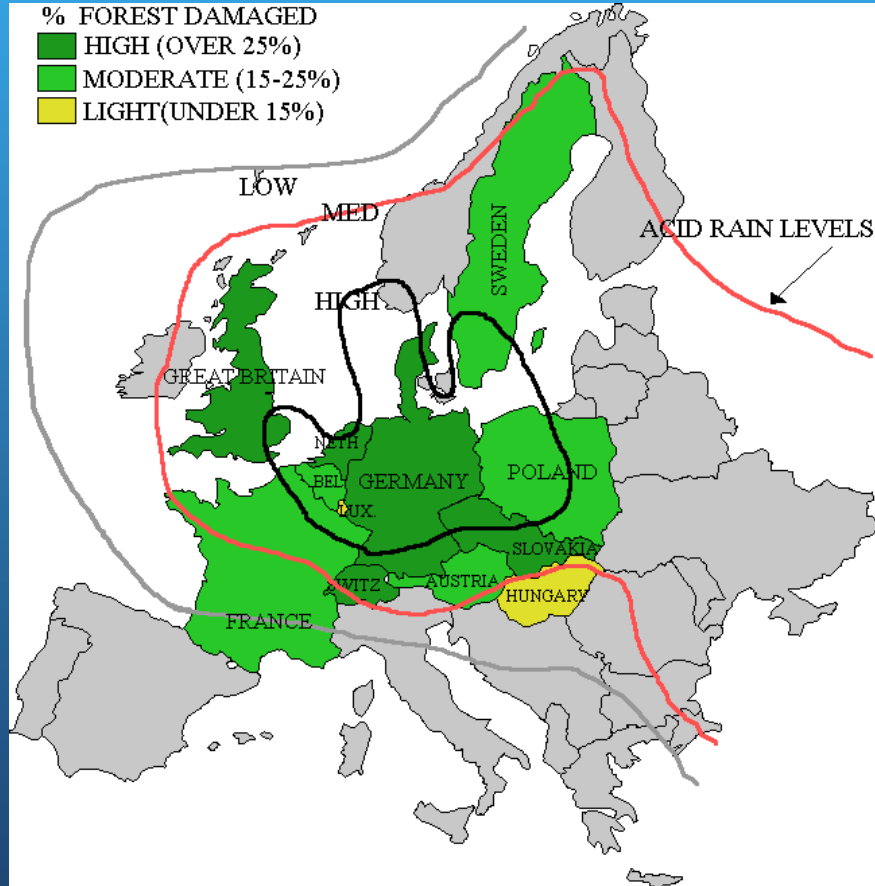
- One problem in controlling acid precipitation is that pollutants may be released in one geographical area and fall to the ground hundreds of kilometers away.
- For example, almost half of the acid precipitation that falls in southeastern Canada results from pollution produced in Ohio, Indiana, Pennsylvania, Illinois, Missouri, West Virginia, and Tennessee.

US Acid Rain



International Conflict

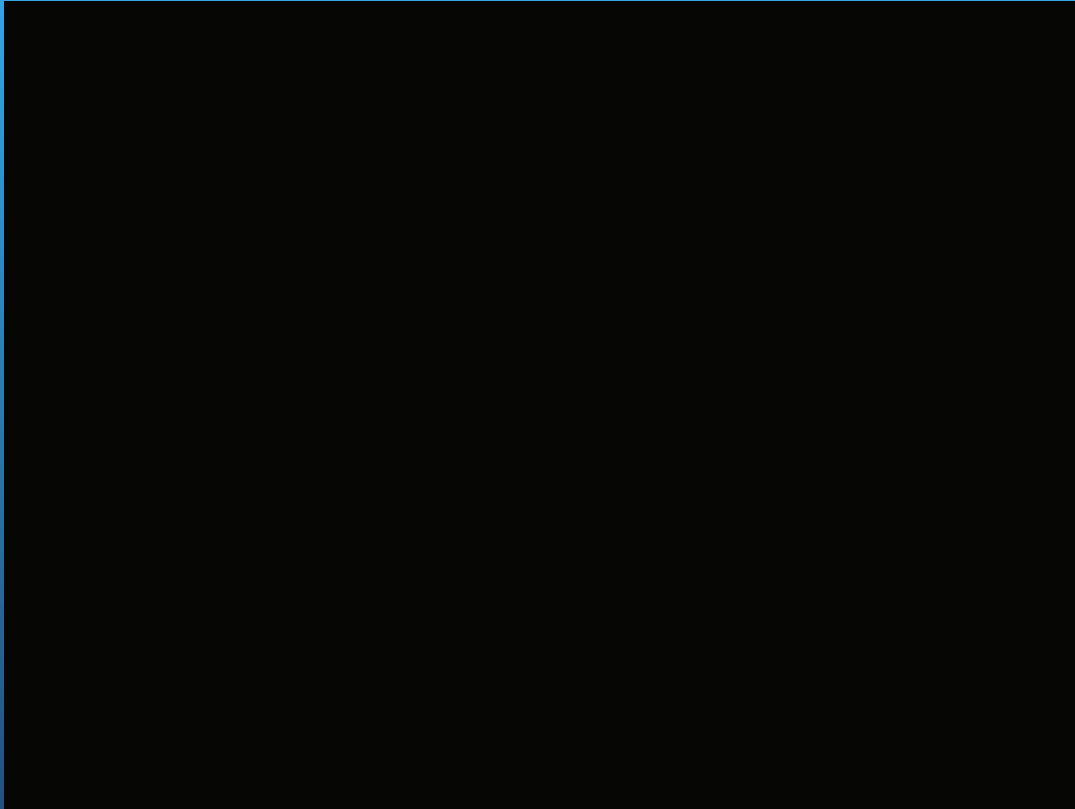




International Cooperation

- Because acid precipitation falls downwind, the problem of solving acid precipitation has been difficult, especially on the international level.
- Canada and the United States signed the Canada-U.S. Air Quality Agreement in 1991. Both countries agreed to reduce acidic emissions that flowed across the Canada-U.S. boundary.
- More international agreements such as this may be necessary to control the acid-precipitation problem.

Preserving the Legacy: Air



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Intelcom. (1999). Preserving the Legacy: Air [Full Video].
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