

Acid Rain

Rain water is naturally acidic because carbon dioxide in the atmosphere combines with water molecules to form carbonic acid. When sulfur dioxide and nitrogen oxides in the atmosphere react with oxygen in the air forming sulfuric acid and nitric acid, acidic precipitation occurs in the form of rain, snow, or dust. Acid precipitation is considered to have a pH of 5.0 or lower. Acid deposition is more commonly used to describe acid precipitation because it includes both wet and dry decomposition.

Discovery of Acid Rain

The first reports of acid rain were in Manchester, England which was an important city during the Industrial Revolution. The relationship between acid rain and atmospheric pollution was found in 1852 by Robert Angus Smith. Acid rain was first used by him in 1872. Although acid rain was discovered in 1852, it was not until the late 1960s that scientists began to study this topic.

Causes

- **The major natural cause that contributes to acid-producing gases in the atmosphere is emissions from volcanoes and those from biological processes that occur on the land, in wetlands, and in oceans. The major biological source of sulfur containing compounds is dimethyl sulfide.**
- **The principal cause of acid rain is sulfur and nitrogen compounds from human sources such as electricity generation and motor vehicles. The gases can be carried hundred of miles in the atmosphere before they are converted to acids and deposited.**
- **There are a large number of aqueous reactions of sulfur which oxidize it leading to the formation of sulfuric acid. The most important oxidation reactions are with ozone, hydrogen peroxide and oxygen.**

Wet Deposition

Wet deposition of acids occurs when any form of precipitation removes acids from the atmosphere and delivers it to the Earth's surface. This can result from the deposition of acids produced in the raindrops or by the precipitation removing the acids either in clouds or below clouds. Wet removal of both gases and aerosol are both of importance for wet deposition.

Dry Deposition

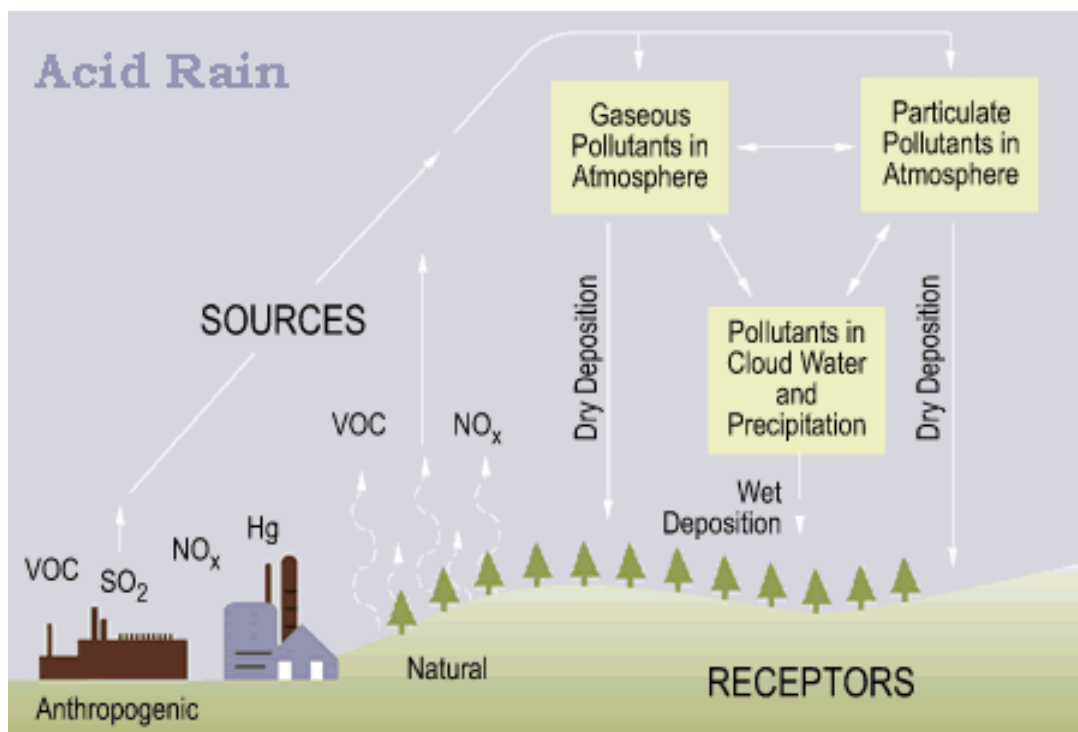
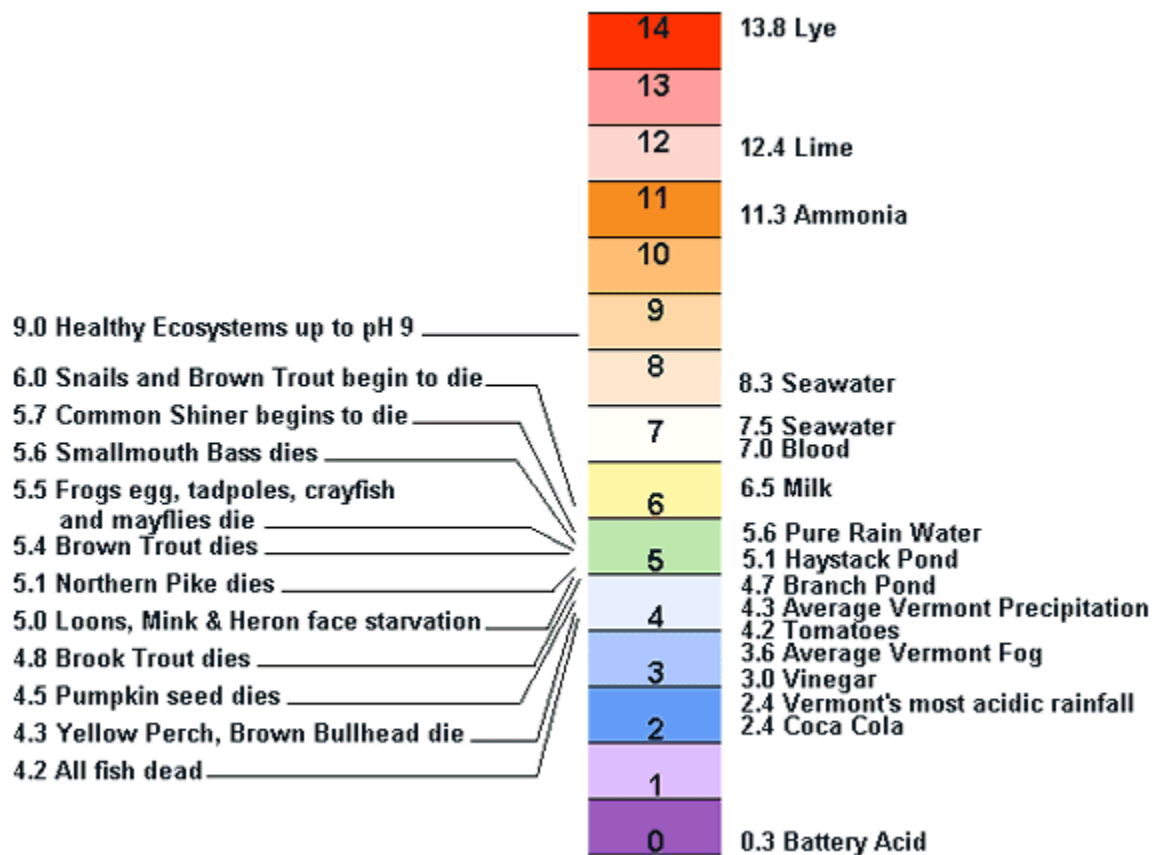
Acid deposition can also occur through dry deposition when precipitation is not involved. This can be responsible for about 20 to 60% of total acid deposition. It occurs when particles and gases stick to the ground, plants and other surfaces.

Effects

- **Aquatic Ecosystems.** Most biological life lives best with a pH level near neutral or 7.0. Aquatic vegetation and animal life vary in their susceptibility to changes in pH (some are more acid tolerant than others). Systems that are well-buffered may not be as affected by acidic runoff. In lakes and streams that become acidified, microorganisms may be affected. If organisms lower in the food chain are reduced, this obviously with effect species higher up that rely on these organisms for food. If the pH level drops below 5.0 most fish species are affected.
- **Soils and Plant Growth.** Acidic soils may affect microorganisms in the soil which play important roles in plant growth. Acidity affects the availability of nutrients essential for plant growth and increases leaching of aluminum and mercury (toxic to plants at high levels).
- **Buildings and Materials.** Acidic precipitation eats away metals and alkaline building materials such as marble and limestone. Urban areas with high levels of automobile exhaust as well as other sources of acidic precipitation experience significant weathering of statues and building materials.
- **Health.** Acid rain does not directly affect human health. It has however been associated and shown to have adverse health effects especially on those who have respiratory disorders.

Prevention

- **Require catalytic converters on auto & truck engines & factory smoke stacks**
- **Require that all chemical wastes be neutralized before disposal**
- **Convert to hydrogen fuels, solar or wind for energy**
- **Clean up smokestacks and exhaust pipes**
- **Restore damaged environments**
- **Turn off lights, computers, and other appliances when you're not using them**
- **Use energy efficient appliances: lighting, air conditioners, heaters, refrigerators, washing machines, etc.**
- **Only use electric appliances when you need them**
Keep your thermostat at 68 F in the winter and 72 F in the summer. You can turn it even lower in the winter and higher in the summer when you are away from home.
- **Insulate your home as best you can**
- **Carpool, use public transportation, or better yet, walk or bicycle whenever possible**
- **Buy vehicles with low NO_x emissions, and maintain all vehicles well**



Sources of Acid Rain

