**Acid Rain**

**What is Acid Rain:**

Acid rain is precipitation containing harmful amounts of nitric and sulfuric acids. These acids are formed primarily by nitrogen oxides and sulfur oxides released into the atmosphere when fossil fuels are burned. These acids fall to the Earth either as wet precipitation (rain, snow, or fog) or dry precipitation (gas and particulates). Some are carried by the wind, sometimes hundreds of miles. In the environment, acid rain damages trees and causes soils and water bodies to acidify, making the water unsuitable for some fish and other wildlife. It also speeds the decay of buildings, statues, and sculptures that are part of our national heritage. Acid rain has damaged Massachusetts lakes, ponds, rivers, and soils, leading to damaged wildlife and forests.

Acid rain, or acid deposition, is a broad term that includes any form of precipitation with acidic components, such as sulfuric or nitric acid that fall to the ground from the atmosphere in wet or dry forms.  This can include rain, snow, fog, hail or even dust that is acidic.

**What Causes Acid Rain?**

Acid rain results when sulfur dioxide (SO2) and nitrogen oxides (NOX) are emitted into the atmosphere and transported by wind and air currents.  The SO2 and NOX react with water, oxygen and other chemicals to form sulfuric and nitric acids.  These then mix with water and other materials before falling to the ground.

While a small portion of the SO2 and NOX that cause acid rain is from natural sources such as volcanoes, most of it comes from the burning of fossil fuels.  The major sources of SO2 and NOX in the atmosphere are:

* Burning of fossil fuels to generate electricity.  Two thirds of SO2 and one fourth of NOX in the atmosphere come from electric power generators.
* Vehicles and heavy equipment.
* Manufacturing, oil refineries and other industries.

Winds can blow SO2 and NOX over long distances and across borders making acid rain a problem for everyone and not just those who live close to these sources.

## The Effects of Acid Rain on Ecosystems

An ecosystem is a community of plants, animals and other organisms along with their environment including the air, water and soil. Everything in an ecosystem is connected. If something harms one part of an ecosystem – one species of plant or animal, the soil or the water – it can have an impact on everything else.

### Effects of Acid Rain on Fish and Wildlife

The ecological effects of acid rain are most clearly seen in aquatic environments, such as streams, lakes, and marshes where it can be harmful to fish and other wildlife. As it flows through the soil, acidic rain water can leach aluminum from soil clay particles and then flow into streams and lakes. The more acid that is introduced to the ecosystem, the more aluminum is released.

Some types of plants and animals are able to tolerate acidic waters and moderate amounts of aluminum. Others, however, are acid-sensitive and will be lost as the pH declines. Generally, the young of most species are more sensitive to environmental conditions than adults. At pH 5, most fish eggs cannot hatch. At lower pH levels, some adult fish die. Some acidic lakes have no fish. Even if a species of fish or animal can tolerate moderately acidic water, the animals or plants it eats might not. For example, frogs have a critical pH around 4, but the mayflies they eat are more sensitive and may not survive pH below 5.5.

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### Effects of Acid Rain on Plants and Trees

Dead or dying trees are a common sight in areas effected by acid rain. Acid rain leaches aluminum from the soil.  That aluminum may be harmful to plants as well as animals. Acid rain also removes minerals and nutrients from the soil that trees need to grow.

At high elevations, acidic fog and clouds might strip nutrients from trees’ foliage, leaving them with brown or dead leaves and needles. The trees are then less able to absorb sunlight, which makes them weak and less able to withstand freezing temperatures.

## Effects of Acid Rain on Materials

Not all acidic deposition is ***wet***. Sometimes dust particles can become acidic as well, and this is called ***dry deposition***. When acid rain and dry acidic particles fall to earth, the nitric and sulfuric acid that make the particles acidic can land on statues, buildings, and other manmade structures, and damage their surfaces. The acidic particles corrode metal and cause paint and stone to deteriorate more quickly. They also dirty the surfaces of buildings and other structures such as monuments.

The consequences of this damage can be costly:

* damaged materials that need to be repaired or replaced,
* increased maintenance costs, and
* loss of detail on stone and metal statues, monuments and tombstones.

## Other Effects of SO2 and NOX

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### Visibility

In the atmosphere, SO2 and NOX gases can be transformed into sulfate and nitrate particles, while some NOX can also react with other pollutants to form ozone. These particles and ozone make the air hazy and difficult to see through. This affects our enjoyment of national parks that we visit for the scenic view such as Shenandoah and the Great Smoky Mountains.

Human Health

Walking in acid rain, or even swimming in a lake affected by acid rain, is no more dangerous to humans than walking in normal rain or swimming in non-acidic lakes. However, when the pollutants that cause acid rain —SO2 and NOX, as well as sulfate and nitrate particles— are in the air, they can be harmful to humans.

SO2 and NOX react in the atmosphere to form fine sulfate and nitrate particles that people can inhale into their lungs.  Many scientific studies have shown a relationship between these particles and effects on heart function, such as heart attacks resulting in death for people with increased heart disease risk, and effects on lung function, such as breathing difficulties for people with asthma.

**EPA’s Acid Rain Program**
Power plants generate the electricity we use every day. Unfortunately, power plants also produce large amounts of nitrogen oxides and sulfur dioxide—the pollutants that cause acid rain—when they burn fossil fuels, especially coal, to produce energy. Congress passed a law called the [Clean Air Act Amendments of 1990](https://www3.epa.gov/acidrain/education/site_students/caaa1990.html), and this law said that EPA should start the [Acid Rain Program](https://www3.epa.gov/acidrain/education/site_students/glossary.html#acid). The program limits, or puts a [cap](https://www3.epa.gov/acidrain/education/site_students/glossary.html#cap) on, the amount of sulfur dioxide that power plants can release into the air and issues [allowances](https://www3.epa.gov/acidrain/education/site_students/glossary.html#allowance) to the power plants to cover their sulfur dioxide emissions. It also reduces the amount of nitrogen oxides that power plants can release.

**Reducing Pollution**
Scientists have found different ways to reduce the amount of sulfur dioxide released from coal-burning power plants. One option is to use coal that contains less sulfur. Another option is to “wash” the coal to remove some of the sulfur. The power plant can also install equipment called scrubbers, which remove the sulfur dioxide from gases leaving the smokestack. Because nitrogen oxides are created in the process of burning coal and other fossil fuels, some power plants are changing the way they burn coal.

**Other Sources of Energy**
A great way to reduce acid rain is to produce energy without using fossil fuels. Instead, people can use renewable energy sources, such as solar and wind power. Renewable energy sources help reduce acid rain because they produce much less pollution. These energy sources can be used to power machinery and produce electricity.

**Cleaner Cars**
Cars and trucks are major sources of the pollutants that cause acid rain. While one car alone does not produce much pollution, all the cars on the road added together create lots of pollution. Therefore, car manufacturers are required to reduce the amount of nitrogen oxides and other pollutants released by new cars. One type of technology used in cars is called a catalytic converter. This piece of equipment has been used for over 20 years to reduce the amount of nitrogen oxides released by cars. Some new cars can also use cleaner fuels, such as natural gas.

Cars that produce less pollution and are better for the environment are often labeled as low emissions vehicles.

Sources: EPA.gov and AirNow.gov

**Smog**

**What is Smog?**

The word “[smog](https://www.livescience.com/environment/060217_smog.html)” is a fusion of smoke and fog, and was originally used to describe the haze that enshrouded coal-burning London at the turn of the 20th century. The burning of large amounts of coal in an area results in a thick, cloudy mixture of smoke and sulfur dioxide.

Nowadays, the term smog is applied more to the yellowish or blackish haze that results when sunlight reacts with nitrogen oxides and volatile organic compounds, which are emitted from the burning of fossil fuels in cars, power plants and factories. The reaction creates tiny airborne particles (called particulate matter) and [ozone](https://www.livescience.com/environment/051215_ozone_mount.html), forming smog.

Smog is especially prevalent in geologic basins encircled by hills or mountains.

It often stays for an extended period of time over densely populated cities or urban areas, such as New York, Los Angeles, Denver, Phoenix, Houston, London, Mexico City, Toronto, Athens, Beijing, and Hong Kong and can build up to dangerous levels.

**How is Smog formed (Causes)?**

The atmospheric pollutants or gases that form smog are released in the air when fuels are burnt. When sunlight and its heat react with these gases and fine particles in the atmosphere, smog is formed. It is purely caused by air pollution. Ground level ozone and fine particles are released in the air due to complex photochemical reactions between volatile organic compounds (VOC), sulphur dioxide (SO2) and nitrogen oxides (NOx). These VOC, SO2 and NOx are called precursors. The main sources of these precursors are pollutants released directly into the air by gasoline and diesel-run vehicles, industrial plants and activities, and heating due to human activities.

Smog is often caused by heavy traffic, high temperatures, sunshine and calm winds. During the winter months when the wind speeds are low, the smog becomes stagnate and stuck in place. It hampers visibility and disturbs the environment.

The time that smog takes to form depends directly on the temperature. Temperature inversions are situations when warm air does not rise instead stays near the ground. During situations of temperature inversions if the wind is calm, smog may get trapped and remain over a place for days.

But it is also true that smog is more severe when it occurs farther away from the sources of release of pollutants. This is because the photo chemical reactions that cause smog take place in the air when the released pollutants from heavy traffic drift due to the wind. Smog can thus affect and prove to be dangerous for suburbs, rural areas as well as urban areas or large cities.

**Effects of Smog**

Smog is harmful to humans, animals, plants and the nature as a whole. Smog is especially harmful for senior citizens, children, and people with heart and lung conditions such as emphysema, bronchitis, and asthma. It can inflame breathing passages, decreasing the lungs' working capacity, and causing shortness of breath, pain when inhaling deeply, wheezing, and coughing.

It can cause eye and nose irritation and it dries out the protective membranes of the nose and throat and interferes with the body's ability to fight infection, increasing susceptibility to illness.

Hospital admissions and respiratory deaths often increase during periods when smog levels are high.

The ground level ozone present in the smog also inhibits plant growth and causes immense damage to crops and forests. Crops, vegetables like soybeans, wheat, tomatoes, peanuts, and cotton are subject to infection when they are exposed to smog.

**Smog Control**

The [1990 Clean Air Act](http://www1.deq.louisiana.gov/portal/PROGRAMS/OzoneActionProgram/OzoneFactsandExperiments/readdat4.htm) established a comprehensive approach to reducing the widespread "criteria" pollutants, which include the ozone, nitrogen oxides, and particulates in smog. EPA sets national standards for criteria pollutants, and the states must take action to ensure that the standards are met. Areas that fail to meet the standards for at least one criteria air pollutant are called "nonattainment areas."

Areas of nonattainment for criteria pollutants have been classified according to the extent of pollution. The five classes for ozone nonattainment range from *marginal* (relatively easy to clean up quickly) to *extreme* (will take a lot of work and a long time to clean up). The 1990 Clean Air Act uses these classes to tailor cleanup requirements to the severity of the pollution and to set realistic guidelines for reaching cleanup goals. Many of the smog cleanup requirements involve motor vehicles (cars, trucks, buses). Also, as the pollution gets worse, pollution controls are required for smaller sources.

Strategies that may be required by law to reduce and control air emissions include state permitting programs, changes in the composition of gasoline, use of alternative fuels (such as natural gas and electricity), and use restrictions imposed by individual communities. Innovative approaches are being taken by local governments across the country to reduce air pollution in nonattainment areas. These include: banning charcoal barbecues and wood burning in stoves or fireplaces when pollution levels are high; developing programs to encourage carpooling and voluntary "ozone actions"; restricting traffic in congested areas; expanding or improving public transportation systems; requiring employers to contribute to employee mass transit costs; assessing "smog fees" on cars in proportion to the number of miles driven and vehicle emissions produced; and even buying and scrapping older, "super-dirty" cars.

Smog can be reduced by implementing modifications, decreasing the consumption of fuels that are [non-renewable](http://www.conserve-energy-future.com/NonRenewableEnergySources.php) and by replacing them with [alternate sources of fuel](http://www.conserve-energy-future.com/AlternativeEnergySources.php) which will reduce toxic emissions from vehicles.

To reduce smog when it is likely to occur or already a problem in your area, individuals can reduce the number of trips you take in your car, reduce or eliminate fireplace and wood stove use, avoid burning leaves, trash, and other materials and avoid using gas-powered lawn and garden equipment.

Sources: EPA.gov and AirNow.gov

**Ozone Depletion**

**What is Ozone depletion?**

The [ozone layer](https://www.epa.gov/ozone-layer-protection/frequently-asked-questions-about-ozone-layer#self) is a concentration of ozone molecules in the stratosphere. About 90 percent of the planet's ozone is in the ozone layer. Stratospheric ozone is a naturally occurring gas that filters the sun's ultraviolet) radiation. A diminished ozone layer allows more UV radiation to reach the Earth's surface.

Ozone molecules in the stratosphere are constantly being produced and destroyed by different types of UV radiation from the sun. Normally, the production and destruction is balanced, so the amount of ozone in the stratosphere at any given time is stable. However, scientists have discovered that certain chemicals react with UV radiation in the stratosphere, which causes them to break apart and release chlorine or bromine atoms. These atoms, in turn, destroy ozone molecules.

**What is the ozone hole?**

One example of ozone depletion is the annual ozone "hole" over Antarctica that has occurred during the Antarctic spring since the early 1980s. This is not really a hole through the ozone layer, but rather a large area of the stratosphere with extremely low amounts of ozone.

It is important to understand that ozone depletion is not limited to the area over the South Pole. Research has shown that ozone depletion occurs over the latitudes that include North America, Europe, Asia, and much of Africa, Australia, and South America.

**Causes of Ozone Depletion:**

Ozone-depleting substances, which include [chlorofluorocarbons](https://www.epa.gov/ozone-layer-protection/frequently-asked-questions-about-ozone-layer#self) (CFCs) and [hydrofluorocarbons](https://www.epa.gov/ozone-layer-protection/frequently-asked-questions-about-ozone-layer#self) (HCFCs), were once used widely in refrigerants, insulating foams, solvents, and other applications. These substances all release chlorine atoms into the stratosphere. A single chlorine atom can break apart more than 100,000 ozone molecules. Other chemicals that damage the ozone layer include [methyl bromide](https://www.epa.gov/ozone-layer-protection/frequently-asked-questions-about-ozone-layer#self) (used as a pesticide), [halons.](https://www.epa.gov/ozone-layer-protection/frequently-asked-questions-about-ozone-layer#self)(used in fire extinguishers), and  methyl chloroform (used as a solvent in industrial processes). As methyl bromide and halons are broken apart, they release bromine atoms, which are 60 times more destructive to ozone molecules than chlorine atoms.

**How do we know that natural sources are not responsible for ozone depletion?**

Although it is true that volcanoes and oceans release large amounts of chlorine, the chlorine from these sources is easily dissolved in water and washes out of the atmosphere in rain. In contrast, CFCs do not break down in the lower atmosphere or dissolve in water. Although they are heavier than air, they are eventually carried into the stratosphere. Scientists use balloons, aircraft, and satellites to measure the composition of the stratosphere. These measurements show a noticeable increase in stratospheric chlorine since 1985. The timing of this increase corresponds with the increase in emissions of CFCs and other ODS caused by human activities.

**Effects of Ozone Depletion:**

For people, overexposure to UVB rays can lead to skin cancer, cataracts, and weakened immune systems. Increased UVB can also lead to reduced crop yield and increased diseases in plants. Phytoplankton, tiny marine organisms that form the basis for many marine food chains, suffer reduced survival rates. UVB radiation has been found to cause damage to early developmental stages of fish, shrimp, crab, amphibians, and other marine animals. Small increases in UVB exposure could result in population reductions for small marine organisms with implications for the whole marine food chain.

Ozone depletion and climate change

ODSs and many of their non-ozone depleting substitutes are potent greenhouse gases that contribute to [climate change](https://www.epa.gov/climatechange). Some ODSs and ODS substitutes have global warming potentials that are several thousand times greater than that of carbon dioxide.

**What is being done to protect the ozone layer?**

Atmospheric levels of these ODS rapidly increased before the implementation of the [Montreal Protocol on Substances that Deplete the Ozone Layer](https://www.epa.gov/ozone-layer-protection/international-treaties-and-cooperation) and its subsequent revisions and amendments. However, the atmospheric levels of nearly all of these substances have declined substantially in the past two decades.

As required under Title VI of the Clean Air Act, EPA is responsible for developing and implementing programs that protect the ozone layer.

**Will the ozone layer recover?**

The ozone layer is expected to return to normal levels by about 2050. But, it is very important that the world comply with the Montreal Protocol; delays in ending production and use of ozone-depleting substances could cause additional damage to the ozone layer and prolong its recovery.

**How can I help to protect the ozone layer?**

While the vast majority of ODS usage is either industrial or commercial, individuals can help in the following ways: Buy air-conditioning and refrigeration equipment that do not use HCFCs as refrigerant, buy aerosol products that do not use HCFCs or CFCs as propellants (aerosol cans should have a “CFC free” symbol on them), conduct regular inspection and maintenance of air-conditioning and refrigeration appliances to prevent and minimize refrigerant leakage, when motor vehicle air-conditioners need servicing, make sure that the refrigerants are properly recovered and recycled instead of being vented to the atmosphere.

Sources: EPA.gov and AirNow.gov

**Air Pollution and Wildlife**

**How is wildlife exposed to air pollution?**

An ecosystem is a community of plants, animals and other organisms along with their environment including the air, water and soil. Everything in an ecosystem is connected. If something harms one part of an ecosystem – one species of plant or animal, the soil or the water – it can have an impact on everything else.

Animals are exposed to air pollutants via three pathways: 1) inhalation of gases or small particles; 2) ingestion of particles suspended in food or water; or 3) absorption of gases through the skin. In general, only soft-bodied invertebrates (e.g. earthworms), or animals with thin, moist skin (e.g. amphibians) are affected by the absorption of pollutants.

**Sources and their effects on wildlife:**

Acid Rain

The ecological effects of acid rain are most clearly seen in aquatic environments, such as streams, lakes, and marshes where it can be harmful to fish and other wildlife. As it flows through the soil, acidic rain water can leach aluminum from soil clay particles and then flow into streams and lakes. The more acid that is introduced to the ecosystem, the more aluminum is released.

Some types of plants and animals are able to tolerate acidic waters and moderate amounts of aluminum. Others, however, are acid-sensitive and will be lost as the pH declines. Generally, the young of most species are more sensitive to environmental conditions than adults. At pH 5, most fish eggs cannot hatch. At lower pH levels, some adult fish die. Some acidic lakes have no fish. Even if a species of fish or animal can tolerate moderately acidic water, the animals or plants it eats might not. For example, frogs have a critical pH around 4, but the mayflies they eat are more sensitive and may not survive pH below 5.5.

Gaseous Pollutants

Gases emitted from industrial processes undergo chemical transformation in the atmosphere in the presence of sunlight to form ozone. Ozone, sulphur dioxide, and nitrogen dioxide primarily affect the respiratory system, and it is likely that birds are even more susceptible to gaseous pollutant injury than mammals due to their higher respiratory rates.

Particulates and Toxins

There are a number of air pollutants that are categorized as particulates. Heavy metals may be released from factories and power plants. Metals may affect the circulatory, respiratory, gastrointestinal, and central nervous systems of animals. Often organs such as the kidney, liver, and brain are targeted. Entire populations can be affected as metal contamination can cause changes in birth, growth, and death rates.

Indirect Effects

In addition to affecting individual animals or populations directly, air pollutants also affect wildlife indirectly by causing changes in the ecosystem. Vegetation affords cover for protection from predators and weather, provides breeding and nesting habitat, and also serves as a food source. Therefore, any change in vegetation could indirectly affect animal populations. Although birds and mammals are not directly affected by water acidification, they are indirectly affected by changes in the quantity and quality of their food resources.

**Reducing Air Pollution Effects on Wildlife:**

Reducing the effects of air pollution on wildlife involves reducing the air pollution itself.

Reducing Acid Rain

A great way to reduce acid rain is to produce energy without using fossil fuels. Instead, people can use renewable energy sources, such as solar and wind power. Renewable energy sources help reduce acid rain because they produce much less pollution. These energy sources can be used to power machinery and produce electricity. Cars and trucks are major sources of the pollutants that cause acid rain. While one car alone does not produce much pollution, all the cars on the road added together create lots of pollution. Therefore, car manufacturers are required to reduce the amount of nitrogen oxides and other pollutants released by new cars. One type of technology used in cars is called a catalytic converter. This piece of equipment has been used for over 20 years to reduce the amount of nitrogen oxides released by cars. Some new cars can also use cleaner fuels, such as natural gas. Cars that produce less pollution and are better for the environment are often labeled as low emissions vehicles.

Smog can be reduced by implementing modifications, decreasing the consumption of fuels that are [non-renewable](http://www.conserve-energy-future.com/NonRenewableEnergySources.php) and by replacing them with [alternate sources of fuel](http://www.conserve-energy-future.com/AlternativeEnergySources.php) which will reduce toxic emissions from vehicles.

To reduce smog when it is likely to occur or already a problem in your area, individuals can reduce the number of trips you take in your car, reduce or eliminate fireplace and wood stove use, avoid burning leaves, trash, and other materials and avoid using gas-powered lawn and garden equipment.

Sources: EPA.gov and AirNow.gov

**Air Pollution and Crops, Trees and Plants**

**How are crops, trees and plants exposed to air pollution?**

Toxic pollutants in the air, or deposited on soils or surface waters, can impact plants in a number of ways.

"Acid rain" is a general name for many phenomena including acid fog, acid sleet, and acid snow. Although we associate the acid threat with rainy days, acid deposition occurs all the time, even on sunny days.

Sulphur dioxide and nitrogen oxides both combine with water in the atmosphere to create acid rain. Acid rain acidifies the soils and waters where it falls, killing off plants. Many industrial processes produce large quantities of pollutants including sulphur dioxide and nitrous oxide. These are also produced by car engines and are emitted in the exhaust. When sulphur dioxide and nitrous oxide react with water vapor in the atmosphere, acids are produced. The result is what is termed acid rain, which causes serious damage to plants.

In addition, other gaseous pollutants, such as ozone, can also harm vegetation directly. Ground-level ozone can lead to reductions in agricultural crop and commercial forest yields, reduced growth and survivability of tree seedlings, and increased plant susceptibility to disease, pests and other environmental stresses (such as harsh weather). As described above, crop and forest damage can also result from acid rain and from increased UV radiation caused by ozone depletion

**Sources and their effects on Crops, Trees and Plants**

Acid Rain

Dead or dying trees are a common sight in areas effected by acid rain. Acid rain leaches aluminum from the soil.  That aluminum may be harmful to plants as well as animals. Acid rain also removes minerals and nutrients from the soil that trees need to grow.

At high elevations, acidic fog and clouds might strip nutrients from trees’ foliage, leaving them with brown or dead leaves and needles. The trees are then less able to absorb sunlight, which makes them weak and less able to withstand freezing temperatures.

Agricultural crops can be injured when exposed to high concentrations of various air pollutants. Injury ranges from visible markings on the foliage, to reduced growth and yield, to premature death of the plant. The development and severity of the injury depends not only on the concentration of the particular pollutant, but also on a number of other factors. These include the length of exposure to the pollutant, the plant species and its stage of development as well as the environmental factors conducive to a build-up of the pollutant and to the preconditioning of the plant, which make it either susceptible or resistant to injury.

Acid rain does not usually kill trees directly. Instead, it is more likely to weaken the trees by damaging their leaves, limiting the nutrients available to them, or poisoning them with toxic substances slowly released from the soil. The main atmospheric pollutants that affect trees are nitrates and sulphates. Forest decline is often the first sign that trees are in trouble due to air pollution. Forests in high mountain regions receive additional acid from the acidic clouds and fog that often surround them. These clouds and fog are often more acidic than rainfall. When leaves are frequently bathed in this acid fog, their protective waxy coating can wear away. The loss of the coating damages the leaves and creates brown spots. When leaves are damaged, they cannot produce enough food energy for the tree to remain healthy. Once trees are weak, diseases or insects that ultimately kill them can more easily attack them. Weakened trees may also become injured more easily by cold weather.

 Ozone

This primary damage resulting from exposure to ground-level ozone is the loss of membrane integrity and function, resulting in visible damage to leaves and needles and the inability to properly perform photosynthesis. These changes result in reduced growth and yield in many plants. Ozone may also increase the severity of many fungal diseases.

**Reducing Air Pollution Effects on Crops, Trees and Plants:**

Reducing the effects of air pollution on plants involves reducing the air pollution itself.

Reducing Acid Rain

A great way to reduce acid rain is to produce energy without using fossil fuels. Instead, people can use renewable energy sources, such as solar and wind power. Renewable energy sources help reduce acid rain because they produce much less pollution. These energy sources can be used to power machinery and produce electricity. Cars and trucks are major sources of the pollutants that cause acid rain. While one car alone does not produce much pollution, all the cars on the road added together create lots of pollution. Therefore, car manufacturers are required to reduce the amount of nitrogen oxides and other pollutants released by new cars. One type of technology used in cars is called a catalytic converter. This piece of equipment has been used for over 20 years to reduce the amount of nitrogen oxides released by cars. Some new cars can also use cleaner fuels, such as natural gas. Cars that produce less pollution and are better for the environment are often labeled as low emissions vehicles.

Ground-level ozone can be reduced by implementing modifications, decreasing the consumption of fuels that are [non-renewable](http://www.conserve-energy-future.com/NonRenewableEnergySources.php) and by replacing them with [alternate sources of fuel](http://www.conserve-energy-future.com/AlternativeEnergySources.php) which will reduce toxic emissions from vehicles.

To reduce ozone in your area, individuals can reduce the number of trips you take in your car, reduce or eliminate fireplace and wood stove use, avoid burning leaves, trash, and other materials and avoid using gas-powered lawn and garden equipment.

Sources: EPA.gov and AirNow.gov

**Air Pollution and Humans**

**How are humans exposed to air pollution?**

Indoor Air pollution

Indoor pollution sources that release gases or particles into the air are the primary cause of indoor air quality problems. Inadequate ventilation can increase indoor pollutant levels by not bringing in enough outdoor air to dilute emissions from indoor sources and by not carrying indoor air pollutants out of the area. High temperature and humidity levels can also increase concentrations of some pollutants.

Outdoor Air Pollution

Outdoor air pollution sources create human exposure to particulate matter, smog and ground-level ozone, nitrogen oxides, sulfur dioxides and carbon monoxide. The effect of this pollution is related to the amount that a person is exposed to and the length of time of that exposure.

**Sources of Pollution:**

Indoor Air Pollution

There are many sources of indoor air pollution. These can include: fuel-burning combustion (fires, gas stoves, etc), tobacco products, carbon monoxide, building materials and furnishings (asbestos-containing insulation, newly installed flooring, upholstery or carpet and cabinetry or furniture made of certain pressed wood products), products for household cleaning and maintenance, personal care, or hobbies, central heating and cooling systems and humidification devices, excess moisture and resulting mold.

Outdoor Air Pollution

Particulate matter pollution comes from automobile, bus and truck exhaust, fuel burning (wood stoves, fireplaces), industry and construction. Smog and ground-level ozone is produced when nitrogen oxides (vehicle emissions) and volatile organic compounds (VOC) chemically react under sunlight. Nitrogen dioxides result from high temperature fuel combustion and atmospheric reactions. Carbon monoxide is formed when carbon-containing fuel is not burned completely and is emitted by motor vehicles more than any other source. Sulfur dioxide is released by industrial sites such as smelters, paper mills, power plants and steel manufacturing plants.

**Effects of air pollution on humans:**

Indoor Air Pollution

Some health effects may show up shortly after a single exposure or repeated exposures to a pollutant. These include irritation of the eyes, nose, and throat, headaches, dizziness, and fatigue. Such immediate effects are usually short-term and treatable. Sometimes the treatment is simply eliminating the person's exposure to the source of the pollution, if it can be identified. Soon after exposure to some indoor air pollutants, symptoms of some diseases such as asthma may show up, be aggravated or worsened.

The likelihood of immediate reactions to indoor air pollutants depends on several factors including age and preexisting medical conditions. In some cases, whether a person reacts to a pollutant depends on individual sensitivity, which varies tremendously from person to person. Some people can become sensitized to biological or chemical pollutants after repeated or high level exposures.

Certain immediate effects are similar to those from colds or other viral diseases, so it is often difficult to determine if the symptoms are a result of exposure to indoor air pollution. For this reason, it is important to pay attention to the time and place symptoms occur. If the symptoms fade or go away when a person is away from the area, for example, an effort should be made to identify indoor air sources that may be possible causes. Some effects may be made worse by an inadequate supply of outdoor air coming indoors or from the heating, cooling or humidity conditions prevalent indoors.

Long-Term Effects may show up either years after exposure has occurred or only after long or repeated periods of exposure. These effects, which include some respiratory diseases, heart disease and cancer, can be severely debilitating or fatal. It is prudent to try to improve the indoor air quality in your home even if symptoms are not noticeable.

Outdoor Air Pollution

People most at risk from breathing outdoor air pollution include people with asthma, children, older adults, and people who are active outdoors, especially outdoor workers. In addition, people with certain genetic characteristics, and people with reduced intake of certain nutrients, such as vitamins C and E, are at greater risk.

Children are at greatest risk from exposure because their lungs are still developing and they are more likely to be active outdoors, which increases their exposure. Children are also more likely than adults to have asthma.

Air pollution can cause the muscles in the airways to constrict, trapping air in the alveoli. This leads to wheezing and shortness of breath. It can make it more difficult to breathe deeply and vigorously, cause shortness of breath, and pain when taking a deep breath, cause coughing and sore or scratchy throat, inflame and damage the airways, aggravate lung diseases such as asthma, emphysema, and chronic bronchitis, increase the frequency of asthma attacks, make the lungs more susceptible to infection, continue to damage the lungs even when the symptoms have disappeared, cause chronic obstructive pulmonary disease (COPD).

These effects have been found even in healthy people, but can be more serious in people with lung diseases such as asthma. They may lead to increased school absences, medication use, visits to doctors and emergency rooms, and hospital admissions.

Long-term exposure to air pollution is linked to aggravation of asthma, and is likely to be one of many causes of asthma development. Long-term exposures to higher concentrations of pollution may also be linked to permanent lung damage, such as abnormal lung development in children.

Recent studies consistently report associations between short-term exposures and total non-accidental mortality, which includes deaths from respiratory causes. Studies suggest that long-term exposure may increase the risk of death from respiratory causes, but the evidence is not as strong as the evidence for short-term exposure.

**Ways to minimize the effects:**

Indoor Air Pollution

Usually the most effective way to improve indoor air quality is to eliminate individual sources of pollution or to reduce their emissions. Another approach to lowering the concentrations of indoor air pollutants in your home is to increase the amount of outdoor air coming indoors. Most home heating and cooling systems, including forced air heating systems, do not mechanically bring fresh air into the house. Opening windows and doors, operating window or attic fans, when the weather permits, or running a window air conditioner with the vent control open increases the outdoor ventilation rate. Local bathroom or kitchen fans that exhaust outdoors remove contaminants directly from the room where the fan is located and also increase the outdoor air ventilation rate.

Outdoor Air Pollution

The EPA’s national and regional rules to reduce emissions of pollutants help state and local governments meet the Agency’s national air quality standards. Actions include vehicle and transportation standards, regional haze and visibility rules, and regular reviews of the national ambient air quality standards (NAAQS).

To minimize the effects on individuals who are at risk, people should monitor the Air Quality Index and avoid outdoor exposure on days with high levels of pollutants. Individually, people can seek to lessen their effect on air pollution by doing a number of things. Choose a cleaner commute — car pool, use public transportation, bike or walk when possible. Combine errands to reduce "cold starts" of your car and avoid extended idling. Be sure your tires are properly inflated. Keep car, boat and other engines properly tuned, and avoid engines that smoke. Use environmentally safe paints and cleaning products whenever possible. Follow manufacturers' recommendations for use and properly seal cleaners, paints, and other chemicals to prevent evaporation into the air. Conserve electricity. Consider setting your thermostat a little higher in the summer and lower in winter. Reduce or eliminate fireplace and wood stove use. Avoid using gas-powered lawn and garden equipment. Avoid burning leaves, trash and other materials.

Sources: EPA.gov and AirNow.gov

**Climate Change**

**What is Climate Change?**

Climate change refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer.

The Earth's atmosphere contains a delicate balance of naturally occurring gases that trap some of the sun's heat near the Earth's surface. This "greenhouse effect" keeps the Earth's temperature stable. Unfortunately, evidence is mounting that humans have disturbed this natural balance by producing large amounts of some of these greenhouse gases, including carbon dioxide and methane. As a result, the Earth's atmosphere appears to be trapping more of the sun's heat, causing the Earth's average temperature to rise - a phenomenon known as global warming. **Global warming** refers to the recent and ongoing rise in global average temperature near Earth's surface. Global warming is causing climate patterns to change. However, global warming itself represents only one aspect of climate change. Many scientists believe that global warming could have significant impacts on human health, agriculture, water resources, forests, wildlife, and coastal areas.

**Causes of Climate Change:**

Over the past century, human activities have released large amounts of carbon dioxide and other greenhouse gases into the atmosphere. The majority of greenhouse gases come from burning fossil fuels to produce energy, although deforestation, industrial processes, and some agricultural practices also emit gases into the atmosphere.

Greenhouse gases act like a blanket around Earth, trapping energy in the atmosphere and causing it to warm. This phenomenon is called the greenhouse effect and is natural and necessary to support life on Earth. However, the buildup of greenhouse gases can change Earth's climate and result in dangerous effects to human health and welfare and to ecosystems.

The choices we make today will affect the amount of greenhouse gases we put in the atmosphere in the near future and for years to come.

**Effects of Climate Change:**

Our Earth is warming. Earth's average temperature has risen by 1.5°F over the past century, and is projected to rise another 0.5 to 8.6°F over the next hundred years. Small changes in the average temperature of the planet can translate to large and potentially dangerous shifts in climate and weather.  A warming climate will bring changes that can affect our water supplies, agriculture, power and transportation systems, the natural environment, and even our own health and safety.

The evidence is clear. Rising global temperatures have been accompanied by changes in weather and climate. Many places have seen changes in rainfall, resulting in more floods, droughts, or intense rain, as well as more frequent and severe heat waves.

The planet's oceans and glaciers have also experienced some big changes – oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising. As these and other changes become more pronounced in the coming decades, they will likely present challenges to our society and our environment.

**Climate Change Effects in NC**

See the attached document.

**Minimizing and Adapting to Climate Change:**

**We can reduce the risks we will face from climate change.** By making choices that reduce greenhouse gas pollution, and preparing for the changes that are already underway, we can reduce risks from climate change. Our decisions today will shape the world our children and grandchildren will live in.

The EPA and other federal agencies are taking action. EPA is working to protect the health and welfare of Americans through common sense measures to reduce greenhouse gas pollution and to help communities prepare for climate change.

You too can take action. You can take steps at home, on the road, and in your school to reduce greenhouse gas emissions and the risks associated with climate change. Many of these steps can save you money; some, such as walking or biking, can even improve your health! Heat and cool your house smartly, seal and insulate your home, Reduce, reuse and recycle. Use water efficiently. Be aware of and change habits that waste energy, like leaving electrical devices (TVs, lights, etc.) on when no one is in the room. You can also get involved on a local or state level to support energy efficiency, clean energy programs, or other climate programs.

"Adaptation" refers to the adjustments that societies or ecosystems make to limit the negative effects of climate change or to take advantage of opportunities provided by a changing climate. Adaptation can range from a farmer planting more drought-resistant crops to a coastal community evaluating how best to protect its infrastructure from rising sea level.

Climate change is already impacting societies and ecosystems around the world, and many impacts are expected to increase as global temperatures continue to rise. While [reducing greenhouse gas emissions](https://19january2017snapshot.epa.gov/climatechange/reducing-greenhouse-gas-emissions) is required to avoid the worst impacts of climate change, a certain amount of global warming is inevitable, due to the long-lasting nature of greenhouse gases already in the atmosphere, and to heat already stored in the oceans. Adapting to the changes that are already underway, and preparing for future climate change, can help reduce the risks societies will face from climate change.

Adaptation measures are already in place in many areas, as the examples below show. These actions can be expanded or modified to prepare for climate change. But additional measures, such as new technologies and policies, may also be needed. Such actions could require time and resources to carry out, so planning now is important.

Agriculture and Food Supply: Develop crop varieties that are more tolerant of heat, drought, or flooding from heavy rains. Provide more shade and air flow in barns to protect livestock from higher summer temperatures.

Coasts: Preserve wetlands and open spaces to protect coastal communities from flooding and erosion from storms and sea level rise. Improve evacuation planning for low-lying areas to prepare for increased storm surge and flooding.

Ecosystems: Protect and expand wildlife habitats to allow species to migrate as the climate changes. Reduce pollution, habitat loss, and other stressors that make ecosystems more vulnerable to climate change.

Energy: Increase energy efficiency to help offset rises in energy consumption, such as from more air conditioning use as temperatures warm. Strengthen energy production facilities to withstand increased flood, wind, lightning, and other storm-related stresses.

Human Health: Set up early warning systems and emergency response plans to prepare for more extreme weather events. Educate people to help them avoid diseases that could become more prevalent as the climate changes, such as those carried by mosquitoes or ticks. Plant trees and expand green spaces in cities to reduce the "urban heat island" effect.

Water Resources: Improve water use efficiency, and build additional water storage capacity. Protect and restore stream and river banks to provide wildlife habitat and safeguard water resources.

Source: EPA.gov

**EPA**

**What is the EPA?**

EPA stands for the United States Environmental Protection Agency. The mission of EPA is to protect human health and the environment.

EPA's purpose is to ensure that:

* All Americans are protected from significant risks to human health and the environment where they live, learn and work.
* National efforts to reduce environmental risk are based on the best available scientific information.
* Federal laws protecting human health and the environment are enforced fairly and effectively.
* Environmental protection is an integral consideration in U.S. policies concerning natural resources, human health, economic growth, energy, transportation, agriculture, industry, and international trade, and these factors are similarly considered in establishing environmental policy.
* All parts of society -- communities, individuals, businesses, and state, local and tribal governments -- have access to accurate information sufficient to effectively participate in managing human health and environmental risks.
* Environmental protection contributes to making our communities and ecosystems diverse, sustainable and economically productive.
* The United States plays a leadership role in working with other nations to protect the global environment.

**Why was the EPA formed?**

* In 1962, Rachel Carson's book 'Silent Spring,' a critical look at pollution in the United States, jump-starts the environmental movement. Carson, a birdwatcher, discovered that heavy use of pesticides was killing off birds and making the forests 'silent.' She also wrote about harmful chemicals used for defoliation in the Vietnam War.
* In 1969, the Cuyahoga River in Ohio becomes so polluted that it catches on fire. The fire helped spur an avalanche of water pollution control activities such as the Clean Water Act and the Great Lakes Water Quality Agreement. By bringing national attention to water pollution issues, the Cuyahoga River fire was one of the events that led to the creation of the federal Environmental Protection Agency.
* In early 1970, President Nixon Signs NEPA, a bill that forms the Council on Environmental Quality (CEQ) to advise the President on the environment and review federal agencies' Environmental Impact Statements, required for projects that would affect the environment.
* On April 22, 1970 the First Earth Day was held. More than 20 million Americans participate in one of the largest grassroots environmental awareness movements in our history. Earth Day is now celebrated every year by almost 1 billion people worldwide.
* Following President Richard Nixon's 'Reorganization Plan No. 3' issued in July 1970, the EPA is officially established on December 2nd, 1970. The agency consolidates federal research, monitoring and enforcement activities in a single agency. EPA's mission is to protect human health by safeguarding the air we breathe, water we drink and land on which we live.

**How does the EPA help to maintain air quality?**

On December 31, 1970 the Clean Air Act of 1970 was passed. With this Act, the Congress authorized the EPA to set national air quality, auto emission, and anti-pollution standards. The standards led to the production of the catalytic converter in 1973 by New Jersey's Engelhard Corporation. In its first 20 years, the Clean Air Act prevented more than 200,000 premature deaths by significantly reducing the presence of lead, sulfur dioxide and other harmful pollutants in the air.

The United States has made great progress since 1970 in cleaning the air, but the job is far from complete. On November 15, 1990, the 1990 Amendments to the Clean Air Act were signed. These amendments set the stage for protecting the ozone layer, reducing acid rain and toxic pollutants, and improving air quality and visibility.

**Maintaining good air quality:**

Transportation:

* Choose a cleaner commute — car pool, use public transportation, bike or walk when possible.
* Combine errands to reduce "cold starts" of your car and avoid extended idling.
* Refuel cars and trucks after dusk.
* Be sure your tires are properly inflated.
* Keep car, boat and other engines properly tuned, and avoid engines that smoke.

Household Tips:

* Use environmentally safe paints and cleaning products whenever possible.
* Some products that you use at your home or office are made with smog-forming chemicals that can evaporate into the air when you use them. Follow manufacturers' recommendations for use and properly seal cleaners, paints, and other chemicals to prevent evaporation into the air.
* Conserve electricity. Consider setting your thermostat a little higher in the summer and lower in winter. Participate in local energy conservation programs. Look for the [ENERGY STAR](https://www.energystar.gov/)  label when buying home or office equipment.
* Consider using gas logs instead of wood. If you use a wood-burning stove or fireplace insert, make sure it meets EPA design specifications. Burn only dry, seasoned wood.

Lawn and Garden Tips:

* Mulch or compost leaves and yard waste.
* Avoid yard work during high pollution days and during the warmest part of the day.

General guidelines:

* Conserve electricity in all ways possible.
* Set your air conditioner at a higher temperature and your heat at a lower temperature.
* Combine errands and reduce trips.
* Use household, workshop, and garden chemicals in ways that keep evaporation to a minimum, or try to delay using them when poor air quality is forecast.

Source: EPA.gov and AirNow.gov