

Introduction

Earth science combines several fields of science to study Earth and the space around it. Geologists study the surface and interior of Earth. Oceanographers study the ocean. Meteorologists study the weather, and astronomers study the universe. Land, water, air, and space are very closely related—what happens to one affects all of the others.

We must use what we know about Earth to improve and safeguard our living conditions, such as the exploration of land for building our homes, observation of air and ocean influences to predict floods and storms, and examination of photographs of geological structures from space to explore new sources of valuable metal deposits. We must depend on Earth science to help us find new resources and to help us to learn to protect and use our Earth wisely.

Protecting the Environment

The **environment** is very delicate. Special care must be taken of the environment if it is going to continue to provide an atmosphere that will support life and all of the natural resources people need to live. Some of these resources, such as minerals, ores, and **fossil fuels**, cannot be replaced. They are said to be nonrenewable. Others, such as the forests, soil, air, and water, can be replaced at a rate close to their rate of use and are renewable. People must learn to use resources wisely and conserve or preserve natural resources for future use.

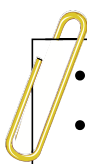


Pollution is a change in the air, water, or land that can be harmful or unpleasant to living things and the environment. Pollution upsets the balance of nature, and if not controlled, causes severe environmental problems. These problems could eventually lead to the extinction of entire populations.

There are several measures society can take to help preserve the balance of nature. One way is to make people aware of the problems of pollution and the need for **conservation**. This can be accomplished through television and newspaper stories, local campaigns to clean up the environment, and education.

Society can help create laws to force large corporations and factories to stop polluting the environment and to stop overusing the natural resources. Laws are also important to keep individuals from burning trash, improperly dumping garbage, and littering. Regulations, such as those requiring licenses to hunt and fish, and placing limits on the numbers of animals killed, are also important.

Conducting scientific research to help keep nature in balance is another measure of preservation. Some of the projects scientists are working on to accomplish this include the following:



- finding new sources for food
- trying to learn how to control the weather so unusable land can be made usable
- looking for ways to get usable minerals and natural resources from the ocean
- trying to find easier and less expensive ways to get fresh water from ocean water
- trying to find less expensive and easier ways to get the oil out of shale
- looking for new sources of energy
- looking for new ways to stop and clean up the harmful effects of pollution
- exploring space to possibly find new resources, answers to problems on Earth, and perhaps a new place for people to live.

Air Pollution

Unwanted, harmful substances in the air are **pollutants**. Air can become polluted. The amount of air pollution varies depending on the conditions in a particular location. Air pollutants especially harmful to human health are **hydrocarbons**, sulfur oxides, particulates, carbon monoxide, and nitrogen oxides. What are these pollutants, and where do they come from?

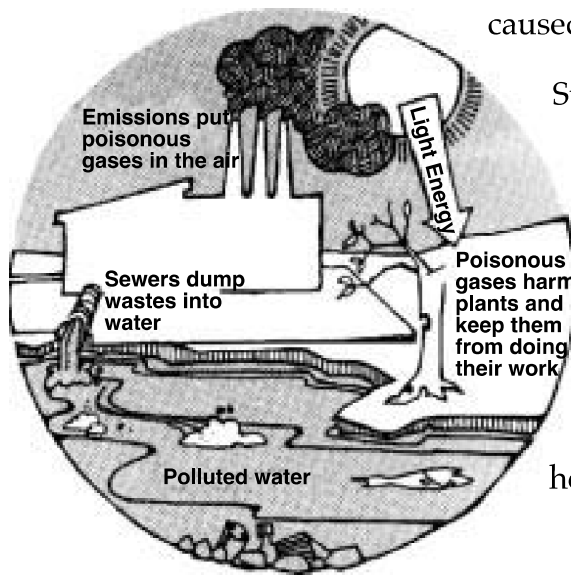
Hydrocarbons. Hydrocarbons are compounds of hydrogen and carbon. Hydrocarbons come from spilled or unburned particles of gasoline. Automobiles that do not have proper fuel settings or pollution control devices may produce hydrocarbons.

Carbon monoxide. Carbon monoxide is another dangerous gas produced by the incomplete burning of fuels. It is colorless and odorless. Its fumes can cause people to become very ill or die. The exhaust from automobiles, gas heaters, and charcoal grills produces carbon monoxide. Therefore, it is important not to operate a car or grill indoors because carbon monoxide poisoning could result.

Sulfur oxides. Fossil fuels, coal and oil, contain small amounts of sulfur. When the fuels are burned, the sulfur is released and combines with oxygen in the air to form sulfur oxides. Sulfur oxides irritate the eyes, nose, throat, and lungs. If sulfur oxides combine with moisture in the atmosphere, a powerful acid called "sulfuric acid" forms. This acid then falls to Earth in rain or snow. This sulfuric acid damages plant leaves, stains the paint on buildings, and causes lung damage.

When sulfuric acid combines with rain, **acid rain** is formed. Acid rain kills fish, damages crops, and pollutes our water supplies. In Florida, the natural limestone rock helps neutralize the sulfuric acid in groundwater so acid rain is not a serious problem. The northern United States is not as fortunate; there, rock is granite and does not buffer the sulfuric acid as limestone does.

Nitrogen oxides. At very high temperatures, nitrogen and oxygen gases in the atmosphere react with each other and form nitric oxide. This gas forms in car engines and comes out of exhaust pipes. Nitric oxide then reacts with oxygen in the air and forms another compound, nitrogen dioxide. The brown haze over many cities is caused by nitrogen dioxide.



Sunlight causes a chemical reaction between nitrogen oxide, sulfur oxide, and hydrocarbon gases. This reaction produces a fog-like pollutant called **smog**. Smog got its name from the words smoke and fog. Most smog seems to come from the burning of fossil fuels. Smog usually occurs in areas with a lot of industry or heavy traffic. Smog creates an

unpleasant odor, a brown haze in the air, and causes the burning of eyes and inflammation of the lungs.

The condition of the air is dependent on other factors besides pollutants. The amount of pollution in an area also depends on geographical features in the area. Very windy areas seldom have much pollution because the wind carries the pollutants away. On the other hand, areas in valleys or with mountains on one side are more likely to have pollution problems because the pollution cannot escape. Weather conditions also have an effect on pollution. Moisture dissolves some pollutants in the air; however, as that moisture becomes a form of *precipitation*, it can pollute the land and waters instead.

Sometimes air pollution is made worse when a layer of cool air gets trapped under a layer of warm air. The warm air acts like a lid and keeps the pollutants near the ground. This effect is called a **temperature inversion** and can create dangerously high levels of pollution. When this occurs, people have to be warned to stay indoors until the weather clears.

Particulates. Particulates are tiny particles of dust, soot, ash, and oil. Burning diesel fuels, coal, oil, and wood gives off particulates. People may experience chest pains or coughing as a result. Particulates can cause lung diseases such as bronchitis, asthma, emphysema, and cancer.

Controlling Air Pollution

Efforts have been made to control air pollution. Laws were passed requiring that unleaded gas be used in new cars in an effort to stop one type of air pollution. Some other important solutions to the problem include the following:

- Laws have been passed, such as the 1970 Clean Air Act, that require industry not exceed safe levels of pollutants. This law is scheduled to be reviewed every five years.
- Warning systems have been installed in areas with high pollution rates.
- More greenery has been planted in cities to reduce the amount of carbon dioxide and increase the amount of oxygen.

- Pollution control devices have been installed on cars.
- Laws have been passed to prohibit the burning of garbage and leaves in residential and other restricted areas.

Every individual can do his or her part to help reduce air pollution. Actions such as car pooling, using public transportation, and making sure our cars are in proper working order can help solve the problem of air pollution.

Water Pollution

Water is one of our most important natural resources. We use fresh water to drink, grow food, produce energy, and manufacture products for transportation and recreation. Both the water on the surface of Earth and the groundwater beneath Earth's surface need to be kept free from pollution. As with air, there are many ways that water can be polluted.



Bacteria and viruses from untreated sewage and animal wastes can cause pollution of the water supplies. This can cause illness and diseases such as typhoid.

Water treatment plants and the addition of chlorine to the water are common methods of preventing this type of pollution.

Water can also be polluted by chemicals from industrial plants, sewage systems, mines, and households. **Phosphates** and **nitrates** found in fertilizers, detergents, and cleaning supplies cause algae and pond weeds in lakes to multiply very

rapidly, using up all of the available nutrients. When large numbers of these plants die, bacteria that decompose them exhaust the oxygen supply. Many other organisms, such as fish, will then die because of a lack of oxygen. **Pesticides** and other poisonous chemicals pollute waters, killing plant life and fish.

The unnatural heating of waters is called **thermal pollution**. Electric power plants that use both fossil fuels and nuclear fuels produce a lot of heat. Power plants use water to condense steam. When the water is returned to the lakes and rivers, it is warmer than before. This upsets the balance of nature. Some organisms cannot live at these higher temperatures. Thermal pollution also disrupts the breeding cycles of some fish. Some people argue that thermal pollution can be beneficial in winter—providing refuge from the cold for manatees, for instance. Manatees congregate in the winter near power plants, such as St. Marks and Crystal River, to take advantage of the warmer waters.

Too much sediment buildup in waterways can create pollution problems. Sand and soil settle to the bottom of rivers and lakes, gradually filling them. These sediments cover up the food supply of fish, causing them to die. Sediment buildup also smothers nonmoving organisms such as oysters and clams and clogs animals' gills, suffocating them. Dredging may then be necessary to open the waterway. Disturbing the bottom by dredging causes other problems such as destroying the nutrients in the sediments and altering the water flow.

Another pollution concern for all bodies of water is the oil spill. Major spills result from tanker collisions in the oceans. These oil spills from tankers spoil our beaches, pollute our ocean water, and cause birds and fish to die. Many cleaning methods are used to remove the oil.

Some of these methods create other types of pollution, however. Burning the oil releases hydrocarbons into the atmosphere. Adding chemicals to breakdown oil introduces other substances into an already stressed environment. Scraping up or collecting oily debris contributes to the problem of waste disposal and scarce landfills. The benefits of cleaning methods must be considered along with their risks and disadvantages.

Cleaning Up an Oil-Tainted Shore

Rocky beaches

1. Heaviest concentrations of oil are removed with pumps, vacuum trucks, and skimmer boats (in shallows near the shore).
2. Workers using buckets, scoops, and absorbents, which attract oil but not water, remove as much crude as possible.

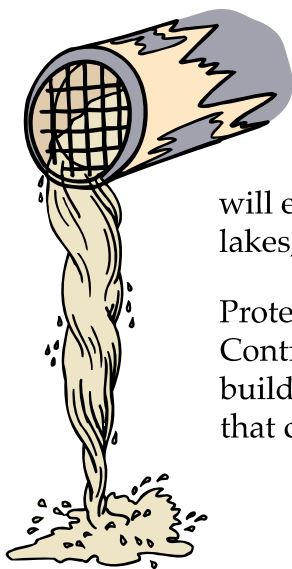
3. High-pressure hoses wash oil back into the water where the oil is trapped by oil booms and vacuumed into trucks.
4. Chemical dispersants are applied where wave action can quickly disperse crude oil.

Sandy beaches

1. Workers collect oil with scoops, shovels, rakes, etc.
2. Heavy equipment is used to push oily sand into wave zones for natural cleansing action.
3. Tractors with raking equipment are used to separate tar balls and clumps of oily sand from the beach.

Muddy shoreline

1. Mud flats and beaches are very sensitive environments, easily damaged by people and equipment.
2. Low-pressure washing with hoses may be used to push oil into open water for skimming.
3. Oil-fouled plants are cut and removed if animal life is endangered.



One of the main forms of pollution of groundwater comes from the dumping of chemical wastes—especially radioactive wastes. When it rains, some of the dangerous chemicals seep down into the water table. These chemicals will eventually be pumped up into wells or enter streams, lakes, or oceans as part of the groundwater.

Protective measures must be taken to keep water pure. Controlling chemical use by farmers and industry and building waste treatment plants are examples of things that can be done to help reduce water pollution.

Land Resources

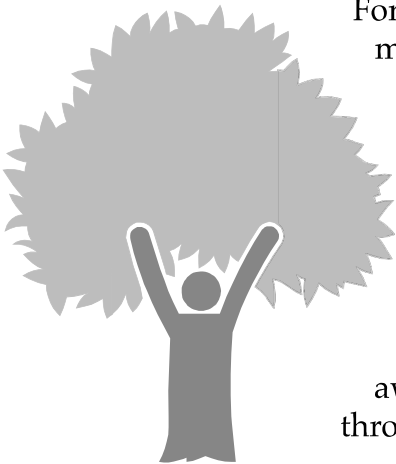
Natural resources found on land must also be conserved and protected from pollution. One of the most noticeable forms of pollution on land is **litter**. To help control litter, laws can be passed to place fines on littering. **Recycling**, which refers to processing materials so they can be used again, can also help to solve the litter problem. Glass bottles, aluminum cans, plastic, and paper are common forms of litter and can all be recycled.



Wastes in landfills, dumps, and septic tanks can cause pollution, if not disposed of properly. The creation of waste management companies and urban sewage treatment plants has helped to eliminate some pollution from these sources.

Chemicals from industry, buried radioactive wastes, and pesticides pollute the land when they enter the soil. Plants grown in this soil may contain these dangerous chemicals. These chemicals are then passed on to people and animals who eat the plants.

Land resources must not only be protected from pollution, they must also be conserved so that there are enough resources for future generations. Crops must be rotated and fertilizers added to keep farm land productive. Some land that is unsuitable for farming because it is too hilly can be terraced or contoured. Land too dry to grow crops can be irrigated in order to become productive. Land used for grazing must be carefully controlled to allow the vegetation to grow back before it is used again.



Forests are another valuable land resource. Trees must be replanted to replace the ones cut down. Since trees prevent erosion, foresters must be careful not to cut down too many trees in a particular place at any given time.

Practicing conservation and controlling pollution of natural resources will allow people to enjoy the gifts of nature for many years to come. It is important that we become aware of the destructive nature of items that we throw away every day. Some of these items require

special disposal methods. Many communities have established hazardous-waste collection sites or other alternatives. Below is a chart of the toxic trash that should be separated from other trash.

Toxic Trash List

- **ammonia**
- **automotive fluids and body filler** for repairing auto body dents and holes
- **batteries** that are disposable or rechargeable (NiCad) batteries
- **caustic cleaners** such as oven cleaners and lye
- **cosmetics** such as fingernail polish and removers
- **electrical devices** with mercury switches
- **florescent light bulbs and their ballasts**
- **fuel** such as charcoal lighter
- **glue, rubber cement, and thinners**
- **herbicides** and their containers (don't rinse)
- **insect sprays, powders, strips, repellants, and their containers** (don't rinse)
- **liquid correction paper and thinner**
- **mothballs**
- **motor-oil cans** (don't rinse)
- **paint, polishers, dyes, and paint thinners** (give away what you don't use; latex paint can be dried out and disposed of in trash)
- **photographic chemicals**
- **pool chemicals**
- **solvents and spot removers**
- **spray cans**
- **wood preservatives** such as sanding sealer and water sealer
- **and anything labeled "dispose of carefully"**



Careers in Earth Science

There are a great number of career opportunities related to the field of Earth science. Some careers require a college degree, but others require vocational and on-the-job training instead. Listed below are brief descriptions of careers in Earth science and the amount of education needed.

Careers in Earth Science		
Career	Description	Education
seismologist	scientist who studies earthquakes	college degree
geology technician	person who assists a geologist by recording data, assisting in the lab running equipment, and making maps	two-year degree
paleontologist	scientist who traces the development of Earth by studying fossils	geology degree plus a masters or doctorate in paleontology
air pollution inspector	Inspects factories, tests samples for pollution, and suggest ways to clean-up pollution	college degree
soil scientist	tests soil, determines what would best grow in it, and suggests ways to make it more productive	college degree
waste water plant operator	tests samples, records data, and runs tests on plant samples	trade school or community college
weather observer	records weather information and sends information to weather stations	1 or 2 years of trade school or community college
surveyor assistant	assists in taking measurements, land clearing, and collecting map data	high school plus on-the-job training
cartographer	draws maps	two years of technical training
coal inspector	inspects and reports on the quality of coal	high school plus on-the-job training

Summary

Protecting our environment and natural resources is extremely important for the future of Earth. Controlling pollution of air, land, and water is one part of the effort. Each of us has a responsibility as a caretaker of the environment. Many different kinds of scientists are working on solutions to today's problems.