

# Human Impact on Earth's Cycles

**FIGURE 10:** Easter Island

Easter Island, located in the southeastern Pacific Ocean, was first inhabited between 400 CE and 700 CE. The human colony grew quickly over the next 1000 years, cutting down the forests for lumber and for building boats. The forests were cleared faster than they could grow back, and eventually the island was left with no trees. Without trees, there was no wood for shelter or boats, the soil washed away, and habitat for the island's animal populations was lost. With no food and the island resources nearly gone, the Easter Islanders disappeared. Today, a small population of people live on the island. The stone monuments placed by the first inhabitants, shown in Figure 10, are a major tourist attraction.



**Predict** What effect did the human population have on Easter Island? How did they change the island's natural cycling of matter and energy?

## Gather Evidence

As you read, record evidence to support or refute the idea that atoms are rearranged in biogeochemical cycles.

**FIGURE 11:** Engine combustion contributes to air pollution.

## Air Pollution

Without human activity, the cycling of carbon, phosphorus, and nitrogen in the Earth system would be in a relatively steady state. Each year humans add synthetic chemicals and materials to Earth, and many of these chemicals cannot be integrated into normal ecosystem functions. The harmful effect of these pollutants can be immediate or delayed, but these effects may add up over time and can disrupt ecosystem functions.

The most common air pollution comes from the waste products produced by burning fossil fuels, such as gasoline and oil that contain carbon, nitrogen, and phosphorus. Burning fossil fuels releases carbon dioxide, methane, nitrous oxide, and other chemicals that pollute the air. Smog is a type of air pollution caused by the interaction of sunlight with pollutants produced by fossil fuel emissions. The nitrogen dioxide in smog reacts with oxygen to produce ozone,  $O_3$ . The ozone produced by reactions of nitrogen dioxide and oxygen tends to stay close to the ground, where it can be harmful to human health and ecosystem functions. However, ozone also exists naturally in the upper atmosphere. There, it acts as a shield protecting Earth's biosphere against harmful ultraviolet rays found in sunlight.

## Algal Blooms

The production of fertilizers and detergents through industrial nitrogen fixation and phosphate mining has increased greatly over the last few decades. When these fertilizers are added to food crops or lawns, rain causes excess nitrogen and phosphorus to run off into nearby streams or lakes. The addition of nitrogen to an ecosystem alters the nutrient balance, which can lead to increases in producers such as algae, causing what is known as an algal bloom.

Algal blooms affect the overall health of an ecosystem, and in the case of aquatic ecosystems, deplete oxygen through a process called eutrophication. When algae die, decomposers break down their bodies, consuming oxygen in the process. The lack of oxygen harms aquatic organisms, and can even lead to major die-off events.



## Cause and Effect

**FIGURE 12:** Eutrophication harms aquatic ecosystems.



### Excess Fertilizer

In many cities, residents over-fertilize their lawns. The excess nitrogen and phosphorus are washed into lakes, streams, and ponds and can lead to eutrophication, as shown in Figure 12. Some cities make efforts to educate their citizens about how to test their soil so they apply just the right amount of nutrients when fertilizing their lawns.



**Model** Make a model describing how over-fertilizing leads to eutrophication. Then use your model to suggest one possible solution to this problem.

## Climate Change

Carbon dioxide emissions released from the burning of fossil fuels have led to a substantial increase in atmospheric CO<sub>2</sub>, as shown in Figure 13. The rate at which carbon dioxide enters the atmosphere as a result of human activities is much faster than the rate at which it is removed by other processes. Combusting fossil fuels and clear-cutting forests are two examples of human activities that lead to increased carbon dioxide levels in Earth's atmosphere.

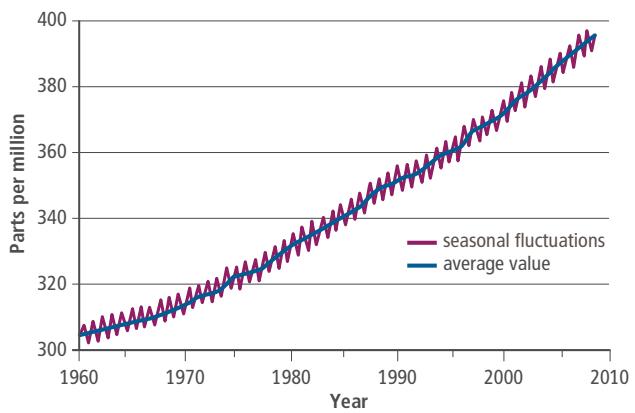


**Analyze** As carbon dioxide is added to the atmosphere, more carbon dioxide also enters the ocean through diffusion. Carbon dioxide reacts with water to produce carbonic acid, which lowers the pH of the water. What effects do you think this might have on marine life?

Carbon dioxide is one of several greenhouse gases. These gases act in a similar manner to a greenhouse for growing plants: They allow sunlight to pass through and provide energy for plant growth, but keep infrared radiation, or heat, from escaping. Increasing the amount of carbon dioxide in the atmosphere has been linked to increasing global temperatures, which has a devastating effect on ecosystems. Some species have already been observed moving into new areas because the changes in the climate make it difficult for these species to continue living in their natural range. Increased carbon dioxide concentrations have also caused the polar ice caps to shrink and sea levels to rise as a result.

### Atmospheric CO<sub>2</sub> at Mauna Loa Observatory

**FIGURE 13:** Atmospheric carbon dioxide levels have risen substantially since 1960.



Source: Scripps Institution of Oceanography, NOAA Earth System Research Laboratory



**Explain** Many scientists worry that the influence humans have on the biogeochemical and hydrologic cycles will cause lasting damage to Earth. Make a list of the activities you perform in a day that may impact one of these cycles. Explain how you are interacting with the cycle and how that could be affecting your local ecosystem. What can you do to decrease your impact?