



International Fund for Animal Welfare

**Animal Action
Education**

Middle/Secondary Level:

Climate Change & Animals

**How Climate Change
Affects Life on Earth**



Introduction

Student Magazine

What is Climate Change?

Climate change affects our everyday lives as we go to school, work, and even travel on vacation. What is climate change? The word *climate* refers to the long-term weather patterns within a defined region including temperature, humidity, wind, and amount and type of precipitation. The Sahara Desert has a hot and dry climate. The Amazon rainforest has a warm and humid climate. Weather is not the same as climate. Weather refers to hourly, daily, or weekly changes in the **atmosphere**, while climate is generally discussed in terms of years, decades, centuries, and millennia. Although the steppe grassland in Russia has a dry climate, it may experience rainy weather one day, and sunny and windy weather the next. Weather is the short-term view; climate is the long-term view.

Climate change refers to significant and long-term changes to a region's climate. These changes can occur over a few decades, or millions of years. Climate change alters entire **ecosystems** along with all of the plants and animals that live there. As climate has changed throughout Earth's history, all living creatures have had to adapt, move, or die out. When these changes happen gradually, ecosystems and species are able to evolve together. A gradual change also gives species the opportunity to adapt to new conditions. But when the change happens very quickly, like it is today, the ability of species to adapt quickly enough or relocate—assuming a suitable location exists—is a big concern.

Scientists analyze data from a variety of sources to monitor climate change. Since 1923, scientists have systematically recorded temperature, precipitation, and atmospheric pressure data in many locations around the world. In addition to standard weather stations, weather services use radar, weather satellites, and high-altitude weather balloons to measure atmospheric temperature, wind, and humidity. Scientists

can also study Earth's climate going back hundreds of thousands of years by examining ice core samples from Greenland and Antarctica.

Earth's atmosphere traps energy from the sun as heat and keeps our planet warm through a process called the **greenhouse effect**. We couldn't live without it. But now, human activities have caused a significant and continuing increase in the levels of **greenhouse gases** in the atmosphere. More greenhouse gases means the atmosphere traps more heat. The processes of industry and burning **fossil fuels** for energy and transportation both release carbon dioxide (CO₂), the most common greenhouse gas behind water vapor. Livestock and landfills generate methane (CH₄), a potent greenhouse gas. Vast amounts of greenhouse gases are also released every day by volcanic eruptions and forest fires. Greenhouse gases from all sources mix in the atmosphere and affect the entire Earth. Because of this, people around the world must work together to address greenhouse gas emissions and global climate change.

Credit: Albert Kasse

On Fire!

Warm, dry conditions can lead to greater risk of large-scale wildfires. From 2002 to 2006, forest fires in the United States released an estimated average of more than 290 million metric tons of CO₂ per year, or about 4% to 6% of the nation's entire CO₂ emissions from all sources. In Alaska, over the same period, fires actually released more CO₂ than the burning of fossil fuels. Increased CO₂ in the atmosphere feeds the greenhouse effect, leading to warmer temperatures and thus the increased risk of even more wildfires.

The Big Thaw

The arctic tundra ecosystem is defined by **permafrost**. This layer of frozen ground means plants are mostly limited to grasses, wildflowers, and lichens, and animals include specially adapted species such as caribou, polar bears, arctic foxes, and many types of insects. The frigid winter weather, short summer growing season, and solid ground protect the tundra from plant and animal invaders and pose a challenge for human settlement.

Today, as the Arctic is warming, the permafrost is thawing. The winters are not so long and cold, the growing season is extended, and the softening ground makes it easier for trees to take root. While this might seem like a good thing, frozen within the permafrost are bubbles of methane and carbon dioxide gases. As the permafrost melts, the trapped greenhouse gases are released, leading to a **feedback loop**—more greenhouse gases trap more heat and cause further warming, which leads to increased thawing and the release of more greenhouse gases.

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Effects of Rising Temperatures

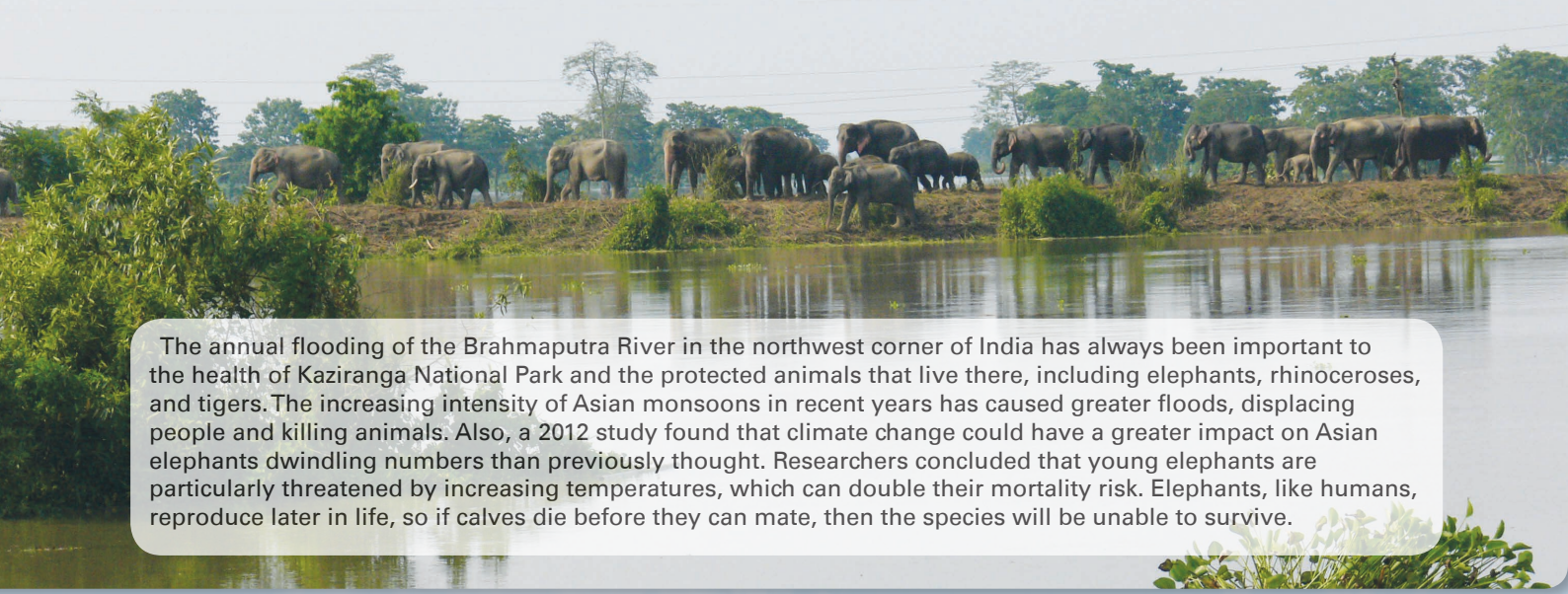
As Earth warms and temperatures rise, regional climates are affected in different ways. Some areas of South and Southeast Asia are experiencing heavier monsoons and rising sea levels, while other areas, such as southern Africa and the American Southwest, are experiencing more severe droughts and crop failures.

Reduced snowpack and shrinking glaciers in the mountains mean less melting snow flowing into rivers, reservoirs, and lakes for fish and wildlife, and less water available for drinking and irrigation. Glaciers in the Himalayan Mountains supply year-round water to more than 2 billion people.

Warmer temperatures also produce increased evaporation, which leads to heavier rainfall and snowfall. But the increased precipitation is unevenly distributed, leading to heavier rainfall in some locations and droughts in others. Heavier snowstorms, stronger hurricanes, more intense heat waves, and extreme rainstorms and resulting flash floods are occurring more frequently around the globe.

Warmer air temperatures also lead to higher ocean temperatures, and warmer oceans affect global ocean currents and associated weather patterns. The Gulf Stream—a strong ocean current that brings warm water from the equator up the east coast of North America and across the North Atlantic to northern Europe—keeps winters in the United Kingdom as much as 9°F (5°C) warmer than they might otherwise be.

International scientists suggest that the Gulf Stream will likely slow down as a result of climate change, reducing its warming effect. While global average temperatures continue to rise, the cooling effect due to the slowing of the Gulf Stream means that northern Europe may not experience as much warming as other regions.



The annual flooding of the Brahmaputra River in the northwest corner of India has always been important to the health of Kaziranga National Park and the protected animals that live there, including elephants, rhinoceroses, and tigers. The increasing intensity of Asian monsoons in recent years has caused greater floods, displacing people and killing animals. Also, a 2012 study found that climate change could have a greater impact on Asian elephants dwindling numbers than previously thought. Researchers concluded that young elephants are particularly threatened by increasing temperatures, which can double their mortality risk. Elephants, like humans, reproduce later in life, so if calves die before they can mate, then the species will be unable to survive.

More powerful tropical storms and more intense monsoon seasons are other examples of changing weather patterns. Over the last 100 years, the average number of hurricanes and tropical storms per year has roughly tripled, closely matching the rise in surface temperatures in the East Atlantic. Further, the intensity, duration, and frequency of those storms have increased substantially since 1970.

Combining the effects of warming trends in the atmosphere and in the ocean, rising sea level is yet another significant effect of climate change. The two main factors affecting sea level is the addition of water volume from the melting of land-based ice, such as glaciers and ice caps, and the expansion of water as it becomes warmer.

Between 1993 and 2003, average sea levels have risen by about 0.12 inches (3 ml) per year, with wide regional variations. Estimates suggest that over the next 100 years, average global sea levels will continue to rise by up to 0.2 inches (5 ml) per year.

Impact on Animals

Warmer temperatures on land and sea, more intense storms and increasing numbers of floods, reduced snow pack and more frequent droughts, and rising sea levels: How will all of these climate changes affect life on Earth? Species have evolved to survive within certain temperature ranges and are able to tolerate variations in weather. The effects of climate change may push some species to the edge of extinction, while other species may flourish.

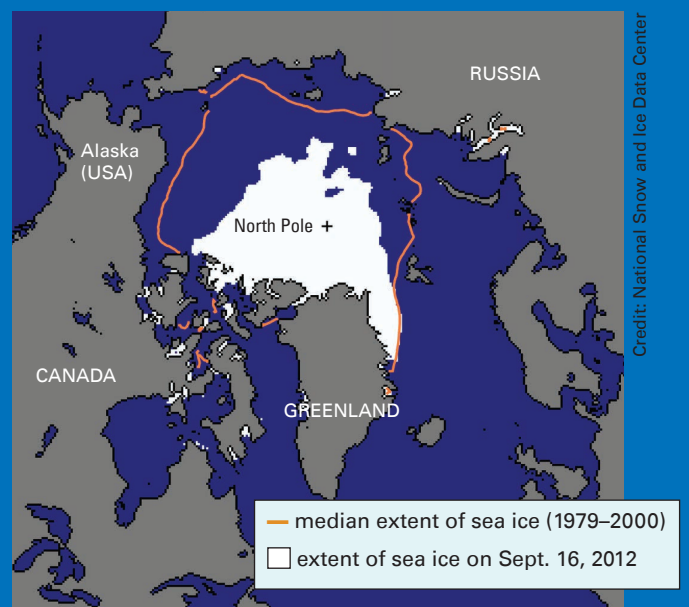
Warmer spring temperatures may cause birds to begin their seasonal migrations or nesting and cause bears to emerge from hibernation earlier than usual. When bears emerge before their regular food sources are available—80% of bears' diets are plants—they may starve or wander into towns in search of food.

For those animals that rely on late summer plants to survive through the winter, warmer, drier summers may affect their ability to find enough food.

Melting Ice

Over the past 30 years, the size of the summer Arctic sea ice—the area of ice covering the Arctic Ocean—has been shrinking. September 2012 marked a new record for the smallest average size of Arctic sea ice since satellite monitoring began in 1979. The average size of the sea ice in September 2012 was less than half of the average size of the sea ice for the month of September from 1979 through 2000.

During that same period, warmer air and ocean temperatures in parts of the North Atlantic have significantly reduced winter sea ice, where harp seals bear their pups. Harp seals need stable winter ice to give birth to and nurse their young until they are old enough to swim and hunt on their own.



Trapped?

The arctic fox lives in the open tundra, and preys on lemmings and voles that burrow underground. Mild winters and melting snow reduce the lemming and vole population by causing their burrows to collapse, thus limiting the arctic fox's major food source. As Arctic temperatures have risen, the red fox has expanded its range into the tundra, preying on the arctic fox and competing with it for food and habitat. And as the tundra's climate warms, experts predict it will be replaced by forest, which is an unsuitable habitat for the arctic fox.



Animals that require cooler temperatures are shifting their ranges to higher elevations or towards the poles as the temperatures in their home ranges rise. The American pika, a small mammal related to rabbits and hares, is adapted to life in the alpine environment. They are extremely sensitive to temperature and can die when temperatures reach only 78°F to 85°F (25.6°C to 29.5°C). As rising temperatures force American pikas to higher elevations, they may not be able to find the right type of rocky slopes that will protect them through the winter or plants that meet their nutritional needs, or they may find that they're already at the top of the mountain with no place to go. In fact, within the last 100 years, many known populations have disappeared.

But shifting ranges is not always a problem—it can create opportunity, too. The red fox, for example, is taking advantage of the warming tundra to extend its range northwards. Anytime a new species enters a region, changes are inevitable. New species can bring parasites and diseases to which the resident species have no resistance. New species are also likely to disrupt the food web, either by predation or through increased competition.

Finally, humans also have a role to play in how climate change affects Earth's creatures. Although we'll experience the same climate effects as every species, we have the unique ability to relieve many of the changes through technology—during a heat wave, we can turn on the air-conditioning; we can ship food from one place to another; or we can move to an entirely different location.

Beyond that, opportunities will emerge—thawing permafrost will open up new areas to human settlement, lack of sea ice in the Arctic will allow for new shipping lanes, and reduced sea ice and melting ice caps will open new areas to oil exploration and mining. All of these opportunities have the ability to greatly affect the animals that call those places home.

The decisions we make about our role in climate change, and how we adapt to the changes as they occur, have the power to affect all life on Earth, both positively and negatively.

International Fund for Animal Welfare

(IFAW) urges policy makers to adopt the strictest precautionary measures in all policies and decisions affecting the welfare and conservation of animals. IFAW focuses on addressing the immediate threats to animals so that they have a chance to adapt to changing climate and habitat conditions in the long term. Working with national and international policy-makers, IFAW advocates for strengthened protection for animals, such as polar bears, at risk from climate change, which is compounded by other threats such as trophy hunting. IFAW encourages individuals to consider how their daily choices impact global warming, and therefore have a direct impact on the welfare of all life on Earth, including humans. For more information, visit www.ifaw.org



Many of India's tigers live in mangrove forests of the Sundarbans, the coastal region along India's border with Bangladesh, where rising sea levels threaten to destroy the mangrove habitat. Some models suggest that as much as 96% of this ecosystem could disappear within the next 50 to 90 years, threatening the survival of tigers living in the Sundarbans.

Introductory Lesson 1: Feedback Loops

Overview: Students will understand the concept of a feedback loop and its role in climate change. They will be able to reason their way through both positive and negative feedback loops, and will understand how both coexist and compete in the climate system.

Learning Outcomes:

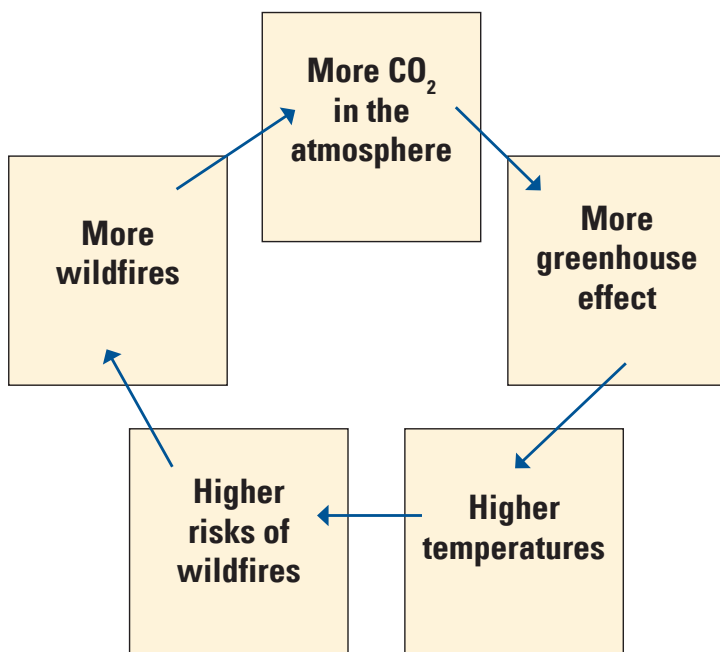
Students will:

- Identify causes and effects within feedback loops.
- Create positive and negative feedback loops.
- Explain the importance of feedback loops to global climate.

Instructional Time:
One 45-minute session

Creating a Feedback Loop

1. Ask students to reread the sidebar “On Fire!” on page 2 of the Student Magazine. Tell them that they will create a climate feedback loop using information from the text.
2. Have students write on a sticky note or create a card that says “More wildfires.” Ask them to identify the direct consequence of an increasing number of wildfires: more CO₂ is released. Then have them create a card that says “More CO₂ in the atmosphere.” Continue the discussion and create subsequent cards for “More greenhouse effect,” “Higher temperatures,” and “Higher risks of wildfires.”
3. Prompt students to arrange the cards on a large sheet of paper to show the relationships between them. Then ask them to draw arrows connecting the cards. Students should form a loop, either by placing the cards in a line with a big arrow that returns to the first card or by placing the cards in a circle.



4. Ask students to reread the sidebar “The Big Thaw” on page 3 of the Student Magazine. Have students follow the same procedure to create the following feedback loop: Permafrost thaws → Trapped methane and carbon dioxide is released into the atmosphere → More greenhouse effect → Higher temperatures → Permafrost thaws, etc.
5. Explain that these are both *positive* feedback loops because they go back to the first card (“More wildfires” and “Permafrost thaws”) and continually feed themselves.
6. Through questions and discussion, guide students through the following *negative* feedback loop: Warming → More vegetation → Plants capture more CO₂ → Less CO₂ in the atmosphere → Less greenhouse effect → Cooling. Point out that the loop does not feedback positively on the first card. In other words, the outcome works against the initial action. This is a *negative* feedback loop. Explain that in nature, we find both positive and negative feedback loops.
7. Point out that the positive feedback loops are not a cause of global warming. They are a mechanism through which changes can accelerate. Global warming would still happen in the absence of positive feedback loops; these positive loops only speed up the process that’s already happening.

Extending the Activity

Guide students through more complicated feedback loops. Highlight the different causes and effects, and ask them to identify whether the feedback loop is positive or negative.

- Warming → More evaporation → More water vapor in the atmosphere (water vapor is a greenhouse gas) → More greenhouse effect → Warming
- Warming → More evaporation → More clouds → More sunlight is reflected by the clouds → Less sunlight is absorbed by the earth → Cooling
- Warming → More melting of polar ice → Less sunlight is reflected by the ice → More sunlight is absorbed by the earth → Warming



Introductory Lesson 2: Land Ice Versus Sea Ice

Overview: Students will understand that the melting of land ice and the melting of sea ice have different impacts. Melting land ice causes sea level to rise and affects coastal habitats, while melting sea ice impacts species that need floating ice to breed and hunt for food.

Learning Outcomes:

Students will:

- Create hypotheses, make observations, and explain results of an experiment.
- Explain the impacts of melting land ice and sea ice.
- Apply experiment observations to the real world.

Instructional Time:
Two 45-minute sessions

Materials:

- Clear plastic tubs (one per group of students)
- Sand and/or rocks (enough for each tub to have “land”)
- Ice cubes (more ice will cause more dramatic effects)



Riggs Glacier, Alaska, 1992



Sea ice, Gulf of St. Lawrence

Modeling Melting Ice

1. Show students pictures of glaciers and ice caps. Explain that this ice is formed on land as a result of snow that has fallen over many thousands of years. Then show students pictures of sea ice. (Examples of both types of ice shown above.) Explain that this ice is formed on the ocean as the water freezes. Tell students that they will be conducting an experiment to learn about the effect of melting ice due to global warming.
2. Give each student a copy of **Worksheet 1**, and give clear plastic tubs to small groups of students. Ask each group to choose a location they will model during the experiment. Ensure that some groups choose to represent land ice and some choose sea ice.
3. Have groups prepare their tubs by piling sand or rocks on one side to create a land surface and adding water to represent the ocean on the other side.
4. Give each group a generous quantity of ice cubes. Students should put the ice on the land surface (to represent land ice) or in the water (to represent sea ice), depending on the location their tub represents. Once the ice has been placed, have them measure and record the water level in the tub.
5. Ask students to make predictions about what will happen in their tub. For each prediction, ask them to explain their reasoning. Record their predictions to revisit later.

Results and Discussion

1. After the ice has melted, have students record the new water level in the tub and note any other observations. Ask students to revisit their predictions and write how their predictions compare with their observations. Then have students calculate the difference between the water levels. They should notice that the water level has increased in the “land ice” tubs, while it has remained the same in the “sea ice” tubs.
2. Ask students what their observations imply in each case. Help them transfer their observations of the plastic tubs to the real world.

- *What would happen if all of the land ice melted?*
Discuss sea level rise and the impact on coastal habitats and communities. Coastal populations would have to move inland or become environmental refugees. Vegetation and ecosystems will change, with the coastal ecosystems disappearing or drifting more inland. Animals would need to adapt or move. If climate change happens too quickly or a suitable environment cannot be found, some species may not be able to adapt rapidly enough and may vanish.

- *What would happen if all of the sea ice melted?*
Opportunities for people:
 - People will be able to travel across the Arctic Ocean, and freight companies will be able to transport goods more easily and more rapidly by boat. (You can show a map of the Arctic Ocean and point to the different countries surrounding the Arctic Ocean. Few students realize how close North America is to Russia and Scandinavia.)
 - New sea floor will open for mining of oil, gas, metals, and minerals.

Consequences for animals:

- Harp seals won't have the stable winter ice where they give birth to and nurse their young. If climate change leaves them no time to migrate and adapt, harp seals might disappear.
- Polar bears will lose their hunting ground, and will need to search for food on land, where environmental pressure, people, and the competition for food may be too great for them to survive.

Worksheet 1: The Effect of Melting Ice

Name: _____ Date: _____

Our ice represents: _____

Beginning water level: _____

Prediction:

Reasoning behind prediction:

.....

Observations:

Ending water level: _____

Difference in water level: _____

How prediction compares with observations:

Application of results to the real world: