

Ecosystem Role Cards

Humans in Northern Europe

Impact: Increased agricultural yields

A longer growing season due to increased temperatures will increase growth of plants. Northern European crops such as wheat and sugar beets will benefit from a longer growing season. Farmers will also be able to grow crops such as sunflowers and soybeans formerly grown only in warmer regions. Because plants need carbon dioxide for photosynthesis, increased carbon dioxide in the atmosphere will help plants to thrive.

Impact: Tourism boom

Warmer temperatures will make northern Europe a more inviting tourist destination. Tourists may prefer to visit cooler mountainous regions, rather than travel to hotter tropical destinations.

Impact: Shifting navigation

Melting sea ice will open up navigation channels in Arctic regions. Materials, including food and fuel supplies, will be able to be shipped from northern Europe through the Northern Sea Route, requiring less time and fuel for transport.

Other means of travel may be negatively impacted by climate change. Extreme weather events, including rain and wind, may damage land-based transportation systems. Flooding can destroy roads and railways. Extreme winds make any mode of transportation more dangerous; windy conditions are hazardous to boats, airplanes, and automobiles.

Impact: Improvements and threats to human health

Warmer temperatures will result in fewer deaths related to cold temperatures. However, heat-related deaths will increase as temperatures rise. Susceptibility to tick-borne diseases like Lyme disease and mosquito-borne diseases like malaria will increase. Children and elderly persons are most susceptible to these diseases. Increased water pollution from bacterial growth, and air pollution due to smog, also pose threats to human health.

Reference:

Joseph Alcamo, et al., "Europe," *Climate Change 2007: Impacts, Adaptation and Vulnerability: A Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, under Publications and Data, ed. M.L. Parry et al. (Cambridge, UK: Cambridge University Press, 2007) accessed June 5, 2013, http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg2_report_impacts_adaptation_and_vulnerability.htm.

Ecosystem Role Cards

Australian Sea Turtles

Impact: Nest incubation threatened

Marine turtles in Australia require nest temperatures of 25-32°C (77-90°F) for egg incubation. Turtles from eggs in nests cooler or warmer than this range will not hatch. Increased temperatures may result in decreased numbers of hatchlings and migration to new habitats with nesting sites of an appropriate temperature.

Impact: Shifting sex ratios

Like many reptile species, the sex of these sea turtles is determined by nest temperature. Warmer nests will produce more female hatchlings, while cooler temperatures result in more males.

Impact: Nest sites at low elevations susceptible to flooding

Sea level rise will have a large impact on low-lying areas, including beaches where turtles lay their eggs. Nesting sites may be destroyed by rising waters and erosion. Turtles may seek new beaches with higher elevation nesting grounds.

Impact: Reduced food availability

Increased temperatures result in damage and sometimes death to coral reefs, an important resource for sea turtles. Sea turtles depend on coral reefs for habitat and eat plants and animals found in reef ecosystems. Warmer waters can result in coral bleaching—a whitening of coral caused by loss of algae. Coral bleaching can destroy reef ecosystems.

Higher temperatures also negatively affect sea grasses that turtles feed on. Severe storms such as cyclones and hurricanes, brought about by global climate change, also damage coral reefs and sea grasses.

Reference:

Colin James Limpus, "Impacts of Climate Change on Marine Turtles: A Case Study," *Migratory Species and Climate Change: Impacts of a Changing Environment on Wild Animals* (Bonn, Germany: UNEP/CMS, 2006) accessed June 10, 2013, http://www.cms.int/publications/pdf/CMS_ClimateChange.pdf.

Ecosystem Role Cards

Polar Bears (*Ursus maritimus*)

Impact: Difficulty getting food

Polar bears hunt seals that live in water underneath floating sea ice. The bears walk on the ice, waiting for a seal to surface for air. This hunting technique takes much less energy for the bear than chasing a seal while swimming. If warmer conditions cause the ice to become unstable or break up earlier in the spring, polar bears will have difficulty getting enough food. In fact, if the ice retreats too far from the shore, bears can drown trying to swim out to the ice.

Underweight females have fewer and smaller cubs that are less likely to survive. When the polar bear mother and cubs leave their den in the spring, it will have been between five and seven months since the mother has eaten. She will need to be successful hunting for her family to survive.

Impact: Loss of shelter

Climate change can affect weather patterns around the world. Increasing numbers and strength of spring rainstorms can cause bear dens to collapse.

Impact: Competition from newly arrived species

As the climate warms, grizzly bears travel farther north. Grizzly bears are more aggressive than polar bears and can out-compete them. They can also interbreed with polar bears, thereby reducing the numbers of non-hybrid polar bears.

Impact: Increased pollution

Many of the air pollutants from the northern hemisphere reach the Arctic through the circulation of air in the atmosphere and the flow of water. Climate change is predicted to bring more precipitation (snow and rain) and higher river flows to the Arctic. This increased precipitation and water flow carries more chemical contaminants. Plants and animals that are low on the food chain absorb these pollutants from the water. Larger animals like seals and polar bears absorb the pollutants from their food in even greater amounts. The concentration of pollutants increases as the pollutants are transferred from prey to predators (bioaccumulation). This pollution negatively affects the health of polar bears and their food.

Reference:

ACIA, *Impacts of a Warming Arctic: Arctic Climate Impact Assessment* (Cambridge, UK: Cambridge University Press, 2004) accessed June 10, 2013, <http://www.acia.uaf.edu/> or <http://www.amap.no/acia/>.

Ecosystem Role Cards

Humans in the Arctic

Impact: Diminishing food supplies and cultural resources

The Inuit people (Native people of the Arctic, formerly known as Eskimos) hunt caribou (deer relatives), which provide them with an affordable food source and help them survive the cold seasons. Caribou numbers have decreased, perhaps due to an inability to travel over melting snow and ice to reach food. People in these regions will have to change their diet based on which foods are accessible. In addition to using caribou for food, Inuit people also value caribou as an important part of their mythology, spirituality, and cultural identity.

Impact: Difficulty traveling

Many Inuit villages are accessible only by dogsled, snowmobile, or sometimes on roads over permafrost (permanently frozen ground). As snow- and ice-free periods get longer, travel by dogsled or snowmobile becomes difficult or even impossible. The permafrost is melting earlier in the spring, turning the roads into mud pits. Traditional hunters travel on ice, which is becoming less stable, making travel more hazardous and even changing animal migration patterns.

Impact: Disease

Resident indigenous populations in the arctic are at risk to failing sanitation infrastructures caused by permafrost and storm surges. This could increase their risk to illness.

Impact: Erosion of coastal lands

Warmer ocean water and air can melt the permafrost that stabilizes coastal land and shorelines. This melting, combined with rising sea levels and shrinking shore and sea ice that once buffered the shore from stormy wave action, can make coastal buildings, pipelines, and roads fall into the ocean and flood low-lying areas, contaminating them with salt.

Impact: Increased accessibility to ships

As the sea ice diminishes, ocean that was previously locked in ice, and therefore impassible to most ships, can now be navigated. For example, a cruise ship recently arrived and unloaded its passengers in Pangnirtung, a remote Inuit village on the southern tip of Baffin Island in the Canadian Arctic that before was accessible only by air or dogsled.

Reference:

ACIA, *Impacts of a Warming Arctic: Arctic Climate Impact Assessment* (Cambridge, UK: Cambridge University Press, 2004) accessed June 10, 2013, <http://www.acia.uaf.edu/> or <http://www.amap.no/acia/>.

"Arctic Challenges," *Oceans North: Protecting Life in the Arctic*, under *Life in the Arctic*, Pew Charitable Trust, accessed June 10, 2013, <http://oceansnorth.org/arctic-challenges>.

Alan J. Parkinson and Birgitta Evengard, "Climate Change, Its Impact on Human Health in the Arctic and the Public Health Response to Threats of Emerging Infectious Diseases," *Global Health Action*, under Vol. 2 (2009), November 11, 2009, accessed June 12, 2013, <http://www.globalhealthaction.net/index.php/gha/article/view/2075/2566>

Ecosystem Role Cards

Arctic Plants

Impact: Thawing permafrost and soil instability

The ice in the permafrost (permanently frozen ground) helps maintain the structure of the soil. Permafrost supports the weight of buildings and roads. When it melts, trees can begin to fall over and sinkholes can develop, which then can fill with water and drown the trees standing there.

Impact: Potential desertification

Even though the total amount of precipitation is projected to increase in the Arctic, precipitation may come at times of the year when plants do not need it, or it may come in extreme storms where most of it runs off to the rivers quickly. Also, as temperatures get warmer, more water will evaporate and plants will lose more water during transpiration. These processes send water back into the atmosphere. It is therefore possible that certain areas could dry out and become polar deserts.

Impact: Thriving pests

When winters are long and very cold and when summers are short, as they traditionally have been in the Arctic, numbers of pests like the spruce bark beetle are kept in check. However, warmer winters mean that more bark beetles will survive each year, and these beetles can kill spruce trees.

Healthy spruce trees have natural defenses against bark beetle attacks. When a beetle tries to bore into the tree to lay her eggs, the tree can push sap out against the beetle to keep her from moving far enough into the tree to lay eggs. When trees are stressed from dry conditions and warmer than normal temperatures, however, they do not have enough sap to fight the beetles.

Impact: Competition from foreign species

As temperatures warm, plant species begin to migrate and survive farther north, invading areas previously inhabited by Arctic species only. Many of the adaptations that allow Arctic species to survive in such cold conditions also limit their ability to compete with invading species. For example, when the temperature gets above about 60°F (16°C), black and white spruce trees are not able to grow as well. If temperatures get too hot, the black and white spruce will not grow at all.

Reference:

ACIA, *Impacts of a Warming Arctic: Arctic Climate Impact Assessment* (Cambridge, UK: Cambridge University Press, 2004) accessed June 10, 2013, <http://www.acia.uaf.edu/> or <http://www.amap.no/acia/>.

Ecosystem Role Cards

Humans on Small Pacific Islands

Solomon Islands, Papua New Guinea, American Samoa

Impact: Coastal erosion

Many of these small islands are less than 4 meters (about 13 feet) above sea level. Sea levels (from glacial melting and thermal expansion) have risen continually in the past century. Higher sea levels encroach on coastal habitat, which affects not only human settlements but natural coastal ecosystems as well. Increased sea levels and saltwater intrusion cause declines in mangrove tree populations. Mangrove roots protect coastlines from erosion, but as sea levels rise over time, mangroves migrate toward the land. If they eventually reach a sea wall or other barrier, they may be reduced to a narrow strip of trees or may disappear altogether.

Impact: Reduced tourism

Algae living on coral reefs are sensitive to warmer water temperatures. If the water is too warm, they die, causing coral to appear white (this is called "coral bleaching"). Tourism from diving will be reduced if coral reefs are damaged.

Impact: Reduced freshwater quality

Low-lying islands depend on rainfall and natural filters such as mangroves to maintain a clean supply of freshwater. Rising sea levels cause salt water to move farther inland, often contaminating drinking water sources. Mangroves act as natural filters, preventing sediment and toxins from reaching island water sources. Reduction of mangrove habitat from rising sea levels would allow more sediments and pollutants to move inland, polluting fresh water sources.

Impact: Lack of food resources

Loss of mangrove and coral reef habitats signals dwindling food resources for islanders. Mangroves provide habitat for many types of seafood, including crabs, clams, and fish. Coral reefs likewise provide habitat for many fish.

References:

Eric Gilman, et al., *Pacific Island Mangroves in a Changing Climate and Rising Sea: UNEP Regional Seas Reports and Studies No. 179* (Nairobi, Kenya: United Nations Environment Programme (UNEP), 2006) accessed June 10, 2013, <http://www.unep.org/PDF/mangrove-report.pdf>.

Nobuo Mimura, et al., "Small Islands," *Climate Change 2007: Impacts, Adaptation and Vulnerability: A Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, under Publications and Data, ed. M.L. Parry et al. (Cambridge, UK: Cambridge University Press, 2007) accessed June 5, 2013, http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg2_report_impacts_adaptation_and_vulnerability.htm.

4. Have each group discuss the impacts described in their passages, and then create a poster illustrating and summarizing the information from their Role Card.

Lesson Variation: Alternately, student groups can communicate the information through pamphlets, Power Point presentations, videos, podcasts, or skits.

5. Reconvene the entire class. Allow groups to present their posters one at a time, explaining the impacts shown. Display completed posters around the classroom or in school hallways.

Discussion Questions

1. Explain how climate change may cause “uncertainty” for populations, communities, and ecosystems.
2. What areas of Earth do you think are most vulnerable to climate change? Why are these areas more sensitive to climate change than other regions?
3. In what ways might some people benefit from climate change?
4. Which effects of climate change that you learned about today will have the greatest impact on Earth’s ecosystems? Give reasoning to support your answer.

5. What are some other living organisms that may be affected by changes in the ecosystem that your group studied? In what ways might they be affected?
6. How might the ecosystem that you live in change if average global temperatures and sea levels continue to rise? How do you think the human community will adapt?

Action Project

Have students write their own ecosystem impact cards. They can research particular populations or communities in the ecosystem where they live, or ecosystems elsewhere in the world. Students can publish their information about impacts of climate change on various ecosystems as a school newspaper article, a podcast, or an online news article.