

Lesson from the Peggy Notebaert Nature Museum's Science on the Go! program. For more information about Science on the Go!, please visit naturemuseum.org.

Lesson Summary

In this lesson, students will create a classroom web to show how living processes, non-living things, earth processes, and economics can be affected by changes in climate. Students will also work in groups to classify their ideas about how climate change will affect the Chicago area.

Lesson Objectives

- Students will be able to evaluate and communicate connections between living processes, non-living things, earth processes, and economics, particularly as they relate to climate.
- Students will be able to construct a concept map showing projected changes in the region's climate.

Time Allotment

50 minutes

Materials

- Ball of yarn (about the size of a baseball)
- Climate Impact Cards (see Advance Preparation)

Per group:

- 11x17 sheet of paper
- Glue stick
- Scissors
- Climate Scenario Sheet
- Climate Scenario Cards

- Climate Scenario Directions

Advance Preparation

Print the Climate Impact Cards, and fold each table in half vertically. Glue the two halves together to make one vertical strip. One side of the strip should contain the category names (e.g. "Air Temperature"), and the other side of the strip should contain descriptions. Cut out the cards.

Copy the Climate Scenario Sheet, the Climate Scenario Directions, and the Climate Scenario cards.

Arrange students in cooperative groups.

Illinois Goals and Standards for Middle/Junior High School

Science:

Goal 12: B.3a, E.3a, E.3b

Goal 13: B.3d

Illinois Learning Standards Incorporating the Common Core

English/Language Arts:

Grade 6: W.2.d, W.3.d, SL.1.c, L.6

Grade 7: W.2.d, W.3.d, SL.1.c, L.6

Grade 8: W.2.d, W.3.d, SL.1.c, L.6

Scientific and Engineering Practices

(A Framework for K-12 Science Education)

- Constructing explanations (for science) and designing solutions (for engineering)
- Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

(A Framework for K-12 Science Education)

- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). (ESS3.D)
- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (ESS3.C)

Vocabulary

Projection

Background Information

Most scientists agree that the global temperature will continue to rise as humans continue to release large amounts of carbon dioxide into the atmosphere. Scientists have made various **projections**, or predictions, about what these changes in temperature might look like. In the Great Lakes region, temperatures are predicted to rise by 3-11°C (5-20°F) in the next century if current emissions practices continue.¹ Though 3°C may seem like a small difference, this change in temperature could impact earth processes, living systems, non-living things, and economics.

As the temperature increases, other earth processes and patterns are likely to change. For example, though total amounts of yearly precipitation in the Great Lakes region is projected to rise only slightly, the distribution and severity of precipitation events are likely to change.² Summers are expected to have periods of intense

drought, and other seasons could have intense precipitation that causes flooding and interferes with planting and harvesting times. The increase in temperature is also expected to cause an increase in evaporation from the surface of the Great Lakes, which can cause a drastic drop in lake levels.³

As earth processes change, many non-living things will be affected as well. For example, as the water levels drop because of increased evaporation, shorelines are likely to change. Water quality could also be impacted as increased runoff during flooding washes chemicals into the water.

Many living things are also likely to be impacted by changing climates. Many species that are well-adapted to their current habitats will likely have to move to new locations once the temperature rises. For example, fish that are adapted to cold Great Lakes water may have to swim deeper in the lakes to find water cold enough to survive. Evergreen trees that can no longer survive in this climate will recede northward, eliminating habitats for many animals, and warmer temperatures may make the Great Lakes region habitable for invasive species that once found the region too cold. Plants and animals that are not able to move to suitable habitats will not survive. Like other living things, humans will be directly impacted by climate change. Warmer temperatures, decreased air and water quality, and changes in humidity could all negatively affect human health. As temperatures rise, costs for winter heating may go down, though air conditioning costs will probably increase.

Humans will also be affected by the economic changes likely to occur as a result of climate change. Agriculture could be drastically affected by changes in growing seasons. Some crops may have increased yields while others suffer.⁴ Some precipitation projections show that summers are likely to be drier, which could make growing more difficult. Irrigation will be necessary, which could drain water from already stressed water sources. Also, severe weather events during planting and harvesting times could impede farmers' abilities to maximize their crop outputs. As lake levels decrease, the shipping industry in the Great Lakes could also be severely affected. The change in lake levels could cause a rise in the cost of shipping, since ships won't be able to carry as much cargo without danger of running aground.⁵

Initial Discussion

1. Ask students what they have heard about how climate change will affect the Chicago area.
2. Choose one response (e.g. "It will get hotter."), and ask if that change could cause anything else to change. (For example, rising temperatures may lead to turn on the air conditioning more often during the summer.)
3. Explain that in this lesson, students will first be looking at the interconnectedness of living things, non-living things, earth processes, and economics. After this, they will learn more about how climate change might impact the Chicago area.

Hands-On Activity

Climate Connections

4. Pass out one climate impact card to each student. Give students a few moments to familiarize themselves with the information on the cards.
5. Begin with the student who has the "Air Temperature" card. Have this student read the contents of his/her card out loud, and give the student the end of the yarn to hold on to.
6. The information on the back of each student card makes explicit connections to several other students' cards. Any student with a card that is directly related to "Air Temperature" should raise his/her hand. (For example, "Evaporation Rates" are directly impacted by air temperature, because higher temperatures result in higher rates of evaporation.)
7. Have one of these students read his/her card out loud, and connect the yarn to him/her. Next, ask if any students' cards are directly related to the topic on the card that was just read aloud. (Using the previous example, "Lake Levels" are directly related to "Evaporation Rates" because increased evaporation of the water in a lake results in a decrease in the lake level.)
8. Continue using the yarn to make connections between the cards. When necessary, cut the yarn and return back to the "Air Temperature" card to begin a new chain. Continue returning back to the "Air Temperature" student until all other students have been connected in some way.



9. Ask students to take a look at how all of these components, both living and non-living are connected. What could happen if the air temperature changes? (Everything else in the web would be impacted, since they are all somehow connected to the air temperature, though some indirectly.)
10. Have the “Air Temperature” student tug gently on each piece of yarn he/she is holding. As the students directly connected to this student feel a slight tug, they should also tug on the yarn that they are holding. Continue until all students can feel a tug.
11. Discuss how changes in air temperature, such as those projected to occur as a result of human emissions of greenhouse gases, can impact all of these different facets of economics, living systems, earth processes, and non-living things. If time allows, make a chart to categorize the climate impact cards according to whether they are related to economics, living systems, earth processes, or non-living things.

Climate Projections

12. Pass out a Climate Scenario Sheet to each group. Allow students time to read the information on the sheet.
13. Pass out an 11x17 piece of paper, a glue stick, scissors, a Climate Scenario Directions Sheet, and a copy of the Climate Scenario Cards to each group.
14. Go through the directions with the students. If necessary, draw a sample web on the board showing students how they should create their own webs.

Emphasize that there are many ways to put these webs together. They are not trying to make the “correct” map, but, instead, they are trying to show that they understand how related factors will lead to specific changes in the Chicago area.

Relate Activity to Concept

15. If time allows, provide students with time to share their webs with surrounding groups.
16. Ask students what they found most interesting about the changes projected to occur in Chicago. Allow several students to share their answers. (See Variations)

Variations

- Instead of discussing which projections students found to be the most interesting, have students complete a journal entry to share their thoughts about the projected results of climate change in Chicago.
- If desired, have students create the climate scenario webs in pairs instead of groups.

Assessment

Collect and grade students’ climate scenario webs according to whether they demonstrate mastery of the lesson objectives.

Evaluate student participation and performance using the assessment rubrics at the back of the curriculum.

Extension Activities

Extended Investigations

Have students research more specific changes likely to occur in the Chicago region as temperatures rise. See Recommended Resources below for reports containing additional information about climate change in the Great Lakes region.

Projection Comparisons

Scientists have made multiple climate projections based on high- and low-emissions scenarios. Compare the likely impacts under these different scenarios.

Global Climate Politics

Investigate current policies on climate change in the United States and other countries.

Recommended Resources

Hall, N.D., Stuntz, B.B. *Climate Change and Great Lakes Water Resources.*

Karl, T.R. Melillo, J.M., Peterson, T.C. *Global Climate Change Impacts in the United States.*

Kling, G.W., et al. *Confronting Climate Change in the Great Lakes Region.*

References

1. http://www.glsa.msu.edu/docs/fact_sheets/GLISA_climate_change_summary.pdf
2. http://glsa.umich.edu/great_lakes_climate/docs/Introduction-Assessing-the-Effects-of-Climate-Change-on-Chicago-and-the-Great-Lakes.pdf
3. <http://www.seagrant.wisc.edu/Home/ToPics/CoastalEngineering/Details.aspx?PostID=632>

4. <http://www.epa.gov/climatechange/impacts-adaptation/agriculture.html>
5. http://climate.dot.gov/documents/works_hop1002/quinn.pdf



Air Temperature

Air temperature is impacted by direct and indirect light from the sun, the concentration of gases in the atmosphere, and the ability of these gases to absorb and reradiate heat.

Climate

The climate of a region is based in large part on the air temperature, precipitation, and weather patterns of the area.

Water Temperature

The water temperature of a body of water can be impacted by the amount of sunlight it receives or the surrounding air temperature.

Evaporation Rates

The amount of water that evaporates from lakes, rivers, streams, and soil is affected by the air temperature and water temperature. As air temperature rises, evaporation rates increase.

Humidity

The humidity, or amount of moisture in the air, changes as the air temperature and evaporation rates change.

Precipitation

The frequency and severity of precipitation in a given region depends in part on the humidity, air temperature, and evaporation rates in the area.

Migration Patterns

Many animals use seasonal clues, such as changing air temperatures, to determine when to migrate.

Growing Seasons

The growing season, or time when plants can be successfully grown, depends on many factors, including climate, air temperature and precipitation.

Plant Hardiness Zones

Plants tend to grow in areas where they are well-suited to the climate conditions. Plants are only able to grow in zones that have the proper temperatures and precipitation levels.

Water Levels

The water level of lakes, rivers, and streams often rise and fall slightly throughout the course of the year based on seasonal runoff, precipitation, groundwater supplies and evaporation rates.

Irrigation

Depending on the amount of natural precipitation occurring, farmers often irrigate (water) their fields to ensure proper crop growth.

Breeding Patterns

Seasonal climate factors such as air temperature and precipitation impact the breeding patterns of many animals.

Shipping

Shipping schedules and costs are based on seasonal weather and water levels.

Water Supply

The amount of water available for human use, particularly in the Great Lakes Basin, is largely dependent on water levels and irrigation needs.

Recreation

Many recreational activities, such as skiing, camping, and baseball, are dependent on such factors as air temperature and precipitation.

Algae Growth

The growth of algae in bodies of water is correlated, or related to, the temperature of the water.

Fish Distribution

The distribution of fish in the Great Lakes is largely dependent on water temperature, and fish native to one area are well-adapted to the water in their region.

Fisheries

The success of fisheries, or places where fish are raised or caught, relies heavily on a consistent distribution of fish in the body of water.

Ice Cover

The amount and thickness of ice covering a body of water depends on the water temperature and the surrounding air temperature.

Forests

The kinds of trees in a particular forest are related to the plant hardiness zone in which the forest is found. The trees are adapted to deal with certain air temperatures and precipitation levels.

Hydropower

Hydropower uses water to generate power, usually in the form of electricity. People's ability to use hydropower is often dependent on water levels in the bodies of water used for power generation.

Shorelines

The size and condition of the shorelines on bodies of water depends largely on water levels.

Groundwater

Groundwater is water found under the surface of the earth. Groundwater supply often depends on precipitation and evaporation rates.

Soil Moisture

The amount of water in the soil depends on evaporation rates and precipitation and is often an indicator of the kinds of plants that can survive in a certain area.

Animal Protection

Animals often use their surroundings for protection. Some aquatic animals, or animals living in water, often depend on ice cover for protection in the winter, and terrestrial, or land, animals sometimes use plants as their homes.

Erosion

Erosion, or the wearing away of the land, depends on factors such as precipitation, plant cover, and soil moisture.

Water Quality

Clean water is an important resource for living things. The quality of a body of water depends on the water temperature, erosion of the surrounding areas, water runoff, and algae growth.

Human Health

Human health can be greatly impacted by changes in air temperature, humidity, and water quality.

Animal Habitats

Animals are well-adapted to certain regions based on the air temperature, plant hardiness zones, and availability of clean water.

Aquatic Organisms

Many aquatic, or water-dwelling, organisms are very sensitive to changes in water quality, water levels, and algae growth.

Heating and Cooling Costs

The environmental and financial costs of heating and cooling homes and offices depend on air temperature, humidity, and, in some cases, the availability of alternative sources of energy.

Invasive Species

The ability of invasive species to move into a new area depends on the air temperature, water temperature, and available habitats in the area.

Climate Scenario Sheet

Climate models for the Great Lakes region of the United States predict that the temperatures in our area will rise 3 to 7°C in the winter and 3 to 11°C in the summer during the next century (100 years). In addition, precipitation patterns are expected to change. Scientists expect that our area will experience more periods of drought (little or no precipitation) during some times of the year and increased flooding during other times of the year. Climate models also show that the periods of drought are likely to fall during the summer months, which is the growing season for this area.

Many living things are likely to be significantly affected by climate changes in our area. As the temperature and precipitation patterns change, native species may no longer be able to survive in their current locations. Plants may be unable to survive with the warmer temperatures, and animals that use those plants for food and shelter will no longer have suitable habitats.

Climate scientists also predict that the levels of the Great Lakes are likely to decrease by about 1 foot by the end of the century because of increased evaporation. (Evaporation rate increases as the temperature increases.) This may not seem like a drastic change in lake levels, but it is enough to disrupt shipping, alter the shorelines, decrease water quality, and have a severe impact on the lives of many living things in the lakes. This is big news for a water system that contains 20% of the world's fresh surface water!

Temperature and precipitation changes are likely to affect humans in many ways as well. Agriculture (farming), fisheries, and health will all be affected. In cities, rising temperatures will likely correlate with lower air quality and increased heat waves, both of which will negatively impact residents' health.

Sources:

- Hall, N.D., Stuntz, B.B. (2007). *Climate Change and Great Lakes Water Resources*. National Wildlife Federation.
- Karl, T.R. Melillo, J.M., Peterson, T.C. (2009). *Global Climate Change Impacts in the United States*. Cambridge University Press.
- Kling, G.W., et al (2003). *Confronting Climate Change in the Great Lakes Region*. Union of Concerned Scientists and The Ecological Society of America.

Climate Scenario Directions

Directions for creating your Climate Projections Scenario Web:

Cut out the Climate Scenario Cards, and choose 6-8 of them to use. Your goal is to create a web showing how these 6-8 things are likely to be affected by climate change in the Chicago area. Pay special attention to how the different topics are related to each other.

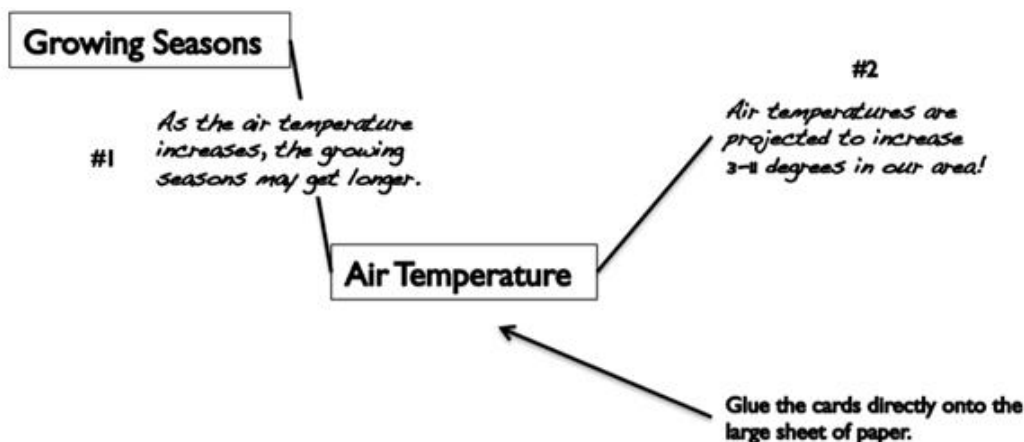
Every time you connect two cards with a line, write down how the cards are related. (See #1 below.)

Try to use as much specific information as possible. Use the Climate Scenario Sheet as a source for information.

For example: "Temperatures are predicted to rise 3-11°C" is more specific than "Temperatures will go up."

If you want to include information about one of the topics, but it does not connect two topics together, you may branch the information off of a single card. (See #2 below.)

Sample:



Climate Projections

Climate Scenario Cards

<p style="text-align: center;">Air Temperature</p> <p>Air temperature is impacted by direct and indirect light from the sun, the concentration of gases in the atmosphere, and the ability of these gases to absorb and reradiate heat.</p>	<p style="text-align: center;">Evaporation Rates</p> <p>The amount of water that evaporates from lakes, rivers, streams, and soil is affected by the air temperature. As air temperature rises, evaporation rates increase.</p>
<p style="text-align: center;">Precipitation</p> <p>The frequency and severity of precipitation in a given region depends in part on the humidity, air temperature, and evaporation rates in the area.</p>	<p style="text-align: center;">Growing Seasons</p> <p>The growing season, or time when plants can be successfully grown, depends on many factors, including air temperature and precipitation.</p>
<p style="text-align: center;">Water Levels</p> <p>The water level of lakes, rivers, and streams change throughout the course of the year based on seasonal runoff, precipitation, groundwater supplies, and evaporation rates.</p>	<p style="text-align: center;">Shipping</p> <p>Shipping schedules and costs are based on seasonal weather and water levels.</p>
<p style="text-align: center;">Water Supply</p> <p>The amount of water available for human use, particularly in the Great Lakes Basin, is largely dependent on water levels and irrigation needs.</p>	<p style="text-align: center;">Recreation</p> <p>Many recreational activities, such as skiing, camping, and baseball, are dependent on such factors as air temperature and precipitation.</p>
<p style="text-align: center;">Human Health</p> <p>Human health can be greatly impacted by changes in air temperature, humidity, and water quality.</p>	<p style="text-align: center;">Water Quality</p> <p>Clean water is an important resource for living things. The quality of a body of water depends on the water temperature, erosion of the surrounding areas, and algae growth.</p>
<p style="text-align: center;">Animal Habitats</p> <p>Animals are well-adapted to certain regions based on the air temperature, precipitation, and the availability of food and clean water.</p>	<p style="text-align: center;">Invasive Species</p> <p>The ability of invasive species to move into a new area depends on the air temperature, water temperature, and available habitats in the area.</p>

Example Climate Scenario Web

