

Streams and Steam

Effects of Climate Change on the Water Cycle

Description

Students play a Chutes-and-Ladders-style board game to understand the effects of climate change on the water cycle. Through the game, students connect how the human enhanced greenhouse effect alters temperatures and precipitation patterns in New Mexico.

Phenomenon

In New Mexico, temperatures are expected to rise, and precipitation patterns are expected to increase in variability.

Objectives

Students will:

- Predict how increasing temperatures on Earth will affect the water cycle
- Synthesize information about the effects of climate change on the water cycle
- Explain how changes in the water cycle affect humans
- Explain the cause of the phenomenon observed in Climate Data Jam

Grade Level

5 – 8

Time

1 Hour

Materials

- *What Is Happening to Our Water?* handout [1 per student]
- *Streams and Steam* handout [1 per student]
- *Streams and Steam* game board [1 per group]
- Optional: *Water Cycle* diagram [1 per group]
- PowerPoint presentation
- Computer and projector*
- Four unique coins (e.g. penny, nickel, dime, and quarter) or different color chips* [1 set per group]
- Die [1 per group]

* Not included in kit

Background

As we saw in Climate Data Jam and Ready, Set, Grow, the availability of water resources for humans, our crops, and our livestock is changing because of the enhanced greenhouse effect and resulting global warming and climate change.

The natural greenhouse effect, modeled in *Insulating You, Insulating Earth* by the towel only, ensures that Earth is warm enough to sustain life. Electromagnetic radiation from the sun, mostly at short wavelengths in the form of light, can pass through the atmosphere and is absorbed by Earth. Earth re-radiates some of this energy back toward space as thermal energy, more of which can pass through the atmosphere and escape into space. However, we are currently experiencing the enhanced greenhouse effect, caused by

increased greenhouse gases in our atmosphere and modeled in Insulating You, Insulating Earth by the towel and mylar blanket combination. As higher levels of greenhouse gases are released into the atmosphere, more of the re-radiated thermal energy from Earth is re-emitted back to Earth instead of escaping to space. This process is causing the average global temperature to increase. The increasing temperature of Earth is called global warming.

Global warming is leading to additional changes to our climate, such as increased frequency of extreme weather events and changing precipitation patterns, wind patterns, and length of seasons. These long-term changes in measures of climate are called climate change. The phenomenon we observe in this unit, increasing temperatures and changing precipitation patterns, are examples of how regional climates are changing.

The water cycle is the movement of water on, in, and above Earth. It is primarily driven by energy from short-wave electromagnetic radiation (sunlight) absorbed by Earth's surface. The effects of climate change on the water cycle are numerous because warmer temperatures affect water cycle processes. Warmer water evaporates more readily, and warmer air can hold more water vapor. As a result, in some areas, the frequency of extreme precipitation events will increase, and other regions will experience more drought. Also, because of higher temperatures, more precipitation is falling as rain instead of snow. In parts of the Northern Hemisphere, the early arrival of warm spring temperatures results in earlier snowmelt and altered streamflow.

Tips for Entire Class Participation

- Students can be divided into small groups of up to 4. Each student will have a coin and will play the Streams and Steam board game against their group members.
- If extra game boards are available, even smaller groups may allow for more participation from some students.

Preparation

1. Plan to divide students into groups of up to four.
2. Set up a computer and projector and display the PowerPoint presentation.

Teaching Guide

Activity Introduction (~10 minutes)

1. Pass out a *What Is Happening to Our Water?* handout to each student.
2. Instruct students to read the excerpt at the top of the handout.
3. Once most students have had enough time to read the excerpt, introduce the activity with the PowerPoint presentation (they will answer the questions on the handout in a few minutes).
 - a. Slide 2: Earth is getting warmer because of the enhanced greenhouse effect, which we modeled in Insulating You, Insulating Earth with the towel and mylar blanket. Increased greenhouse gases in the atmosphere have resulted in global warming, including higher global surface temperatures and higher air and water temperatures. (Review the greenhouse effect and global warming if needed.)
 - b. Optional: Pass out copies of the *Water Cycle* diagram.
 - c. Ask students to draw on what we learned in Climate Data Jam and Ready, Set, Grow, their understanding of the water cycle, and the excerpt at the top of *What Is Happening to Our Water?* to predict the effects of warmer air and water temperatures on the processes of the water cycle. Direct them to write their predictions on the handout. Students should

recall that warmer air is related to changing precipitation patterns in New Mexico and that warmer air leads to increased evapotranspiration rates.

Playing Streams and Steam (~30 minutes)

1. Divide students into groups of four.
2. Pass out a *Streams and Steam* handout to each student.
3. Pass out a *Streams and Steam* game board to each group.
4. Slide 3: This is the *Streams and Steam* game board. The game is played like “Chutes and Ladders.”
5. Slide 4: Rules of the game:
 - a. Every player rolls the die. The highest number goes first.
 - b. Players follow from left to right.
 - c. All players begin with their coin on the start space.
 - d. Roll the die and move the coin the number of spaces indicated.
6. Slide 5: Rules of the game (continued):
 - a. When a player lands on a space at the top of a stream, they “raft” down the stream (in the direction of the arrows) by moving their coin to the square at the bottom of the stream.
 - b. When a player lands on a space at the bottom of a column of steam, they rise up the column of steam by moving their coin up to the square at the top of the steam column (in the direction of the arrows).
7. Slide 6: Rules of the game (continued):
 - a. The squares without pictures do not require any further action. Rest there until your next turn.
 - b. Two or more players may stop at the same square.
 - c. The first player to cross into the Finish space wins the game. An exact roll of the die is not required.
8. Slide 7: On the *Streams and Steam* handout, tell students that they will list all of the causes and effects that each student from their group lands on during the game. On the game board, causes are written in the beginning stream or steam square, and effects are listed in the square where the stream or steam ends. Example: cause – increased evaporation; effect – more water in the atmosphere.
 - a. Instruct students only to write each pair of causes and effects once if they landed on it multiple times.
 - b. Instruct students to use the Key of Possible Action Types on page 1 to write in the third column possible action types that can be taken to mitigate or adapt to the cause and effect listed.
 - c. Instruct students to look at the example that has been done on their handout.
 - d. Keep this slide up as students play the game for their reference as they complete the third column of their table.
 - i. Water Conservation: use methods to decrease water use.
 - ii. Mitigating Climate Change: use methods to reduce greenhouse gas emissions.
 - iii. Risk Management Planning: follow procedures to avoid or minimize the impact of climate change.
9. Pass out a set of four unique coins and a die to each group. Ask students to give each player one coin and begin playing.
10. Play as many rounds of the game as time permits. One round of the game takes approximately 10 to 15 minutes.

Results and Conclusions (~20 minutes)

1. Slide 8: Ask students to volunteer to summarize the effects of climate change on the water cycle that they learned by playing *Streams and Steam*. Initiate a class discussion:
 - a. Because surface, air, and water temperatures on Earth are increasing, there is a higher rate of evaporation of water into the atmosphere. This was modeled by the increasing transpiration cost in Ready, Set, Grow. Warmer air holds more water, which changes precipitation patterns. Also, water vapor is a greenhouse gas, so more water in the atmosphere further enhances the greenhouse effect and changes the climate, which we saw in Insulating You, Insulating Earth.
 - b. As was predicted in Climate Data Jam, we will experience drought in some areas. As climate change intensifies, climate scientists predict less rainfall in the Mediterranean, southwest North America, and southern Africa.
 - c. Also seen in Climate Data Jam, Earth will receive increased precipitation in some areas. More precipitation is predicted in Alaska and other high latitudes of the Northern Hemisphere and near the equator.
 - d. As global surface temperatures continue to increase, most areas on Earth will have warmer winter temperatures.
 - i. Warmer winter temperatures mean that more precipitation falls as rain instead of snow. Snowpack will be reduced, and there will be less water stored in snow to supply watersheds.
 - ii. With warmer winters and spring-like temperatures coming earlier, snow is melting earlier, altering the timing of streamflow. The increased temperature in springtime increases evaporation from surface water bodies, reducing overall streamflow. This generally means that less water is available during late spring and summer months when demand is highest for crops, livestock, and general public use.
2. To answer question 1 on page 2 of the handout, ask students to explain how these changes to the water cycle will affect humans [possible answers: less water available for crops, livestock, and general public use; less food available because of decreased water supply for crops and livestock and increased water temperatures in fisheries; loss of life and property due to flooding and more extreme weather events; increased soil erosion due to flooding and drought; less snow for recreation; changes in the ability to produce hydroelectric power because of changes in streamflow].
3. Slide 9: Instruct students to think in more detail about mitigation and adaptations to the effects of climate change on the water cycle. Guide them to fill in the table in question 2 on page 2 of the handout. Ask them to choose three effects from the game table and give an example of an action that could be taken to respond to each effect. Students may need guidance on this table. Refer to the Answer Key for example solutions to the effects modeled in the board game. Possibly facilitate a whole-class discussion surrounding these solution-based actions.
4. Slide 10: Have students respond to conclusion question 3 of their handout. Ask them to revisit the initial phenomenon presented in Climate Data Jam: “In New Mexico, temperatures are expected to rise, and precipitation patterns are expected to increase in variability” and to explain why this phenomenon is predicted in New Mexico. Students can write out answers or draw an infographic to explain why these climate conditions are expected.

Extensions

1. Students read and discuss the National Public Radio (NPR) article, “There’s a Big Leak in America’s Water Tower.” <http://www.npr.org/2014/08/27/341372550/theres-a-big-leak-in-americas-water-tower> Following the reading, students can predict how climate change will affect organisms, directly or indirectly, in their region.

Additional Resources

1. National Aeronautics and Space Administration (NASA), Earth Observatory. The Water Cycle and Climate Change. Web. Accessed 7 May 2015.
<<http://earthobservatory.nasa.gov/Features/Water/page3.php>>.
2. An online quiz about the effects of global warming on the water cycle for students:
National Oceanic and Atmospheric Administration (NOAA), Ocean Explorer. Global Warming and the Water Cycle. Modified 12 Feb. 2013. Web. Accessed 30 Apr. 2015.
<http://oceanexplorer.noaa.gov/edu/learning/7_water_cycle/activities/global_warming.html>.

This lesson has been adapted for New Mexico Climate Champions from “Streams and Steam” by the Asombro Institute for Science Education and the Southwest Climate Hub. < <https://swclimatehub.info/education/climate-change-and-water-cycle/day4>>