

Food and Water Supplies Under Stress

Introduction: Students will understand how human needs for food and water are fulfilled and how climate change will impact the agriculture industry and our freshwater supplies.

Grade Level & Subject: Grades 9-12. Earth Science, Environmental Science, Social Studies, and Geography.

Length: Two class periods, with option for longer project.

Objectives:

- Learn how climate change impacts agriculture and water supplies.
- Examine how human activity can affect the availability of global food and water supplies.
- Explore how students' personal activities can have an impact on the environment.

Assessment: Students will be assessed based on participation in class discussions and understanding of the topic. Comprehension of the material can be based on completion of the provided worksheet as well as two separate written assignments.

Next Generation Science Standards Addressed:

This lesson addresses the following [Next Generation Science Standards](#):

- **HS-LS2-7.** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- **HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- **HS-ESS3-2.** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- **HS-ESS3-4.** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- **HS-ESS3-5.** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
- **HS-ETS1-1.** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Materials:

- Computers with internet access
- 1-liter water bottle
- USGS Water Usage Questionnaire: <http://ga.water.usgs.gov/edu/sq3.html>.
- Earth Day Network Ecological Footprint Quiz: <http://www.earthday.org/take-action/footprint-calculator/>

Warm-up: Examining Agriculture

1. The purpose of this activity is to emphasize the limited supply of freshwater worldwide. Freshwater, the bodies of water containing low concentrations of salt, is being used at a higher rate than it is being renewed, and climate change threatens to further reduce its availability. Demonstrate the availability of freshwater by drawing one liter of water into a bottle (one liter being 34 fluid ounces). Pour 33 ounces of the water (roughly 97%) into a second container. The water in the second container represents the amount of water on Earth that is salt water, and the remaining water in the first bottle is the amount of freshwater on Earth. Next, pour 1 ounce of the remaining water from the first bottle into a third container. This amount (about 2% of the liter) represents the amount of freshwater that is locked in ice caps and glaciers. The remaining water in the original bottle, 0.3% of the liter, is the amount of freshwater available for everyday use. This represents all the potable water found in rivers, lakes, streams, and groundwater aquifers on Earth. This demonstration shows the relatively small amount of freshwater water available to support all the living beings on planet Earth.
2. Now, connect the idea of limited water supplies to the students' activities by asking them to consider how much water they had in their last meal. Make sure they include the water that was included in the actual food to understand that consuming water means more than drinking from a glass. After this, have them consider the water involved in growing the food that they ate, or that supported the animal that produced their meal. A table of common livestock and the amount of water needed daily to support them is listed below.

Animal	Gallons of water/day
Beef Cow	<u>18</u>
Dairy Cow	<u>27</u>
Sheep/Goat	<u>5</u>
Swine	<u>3</u>
Horse/Mule	<u>12</u>
Chicken/Duck	<u>0.05</u>
Turkey	<u>0.17</u>

3. Once students understand the enormous amount of resources that go into producing our food, provide the students with some numbers on overall water usage in agriculture. These numbers reflect the amount of water it takes to produce the specified amount of each product:

Coffee, 1 gallon: 1,056 gallons

1/3 Pound Burger: 660 gallons

Milk, 1 gallon: 2,000 gallons

Cotton t-shirt: 2,700 gallons

Cheese, 1 lbs: [2,500 gallons](#)

Rice, 2 lbs: [600 gallons](#)

Sugar, 4 lbs: [950 gallons](#)

Wheat, One Loaf: [240 gallons](#)

4. Now begin to discuss the impact of climate change on agriculture. Remember that climate change will have different impacts in different regions of the world, so while some places will experience extreme weather events and flooding, other parts will likely experience drought. Either way, these changes in climate will greatly affect the ability of people to produce food. Historically, humans have overcome agricultural obstacles through selective breeding and irrigation. Plants and animals are selectively bred to cultivate certain traits desirable for agriculture, such as producing more fruit or having a higher tolerance for heat. Irrigation redirects the flow of a naturally occurring body of water to assist in crop production. Often, water is removed at a rate faster than can be replenished, and in cases where climate change causes drought, irrigation may cause water supplies to dwindle or dry out. On the other hand, floods in other areas used to a lower flow may destroy crops and livestock.

5. As world temperatures climb agricultural zones will shift away from the hot equator and toward the increasingly temperate poles. Areas such as Iceland and Russia have recently found themselves able to grow crops they could never grow before. However, the polar regions have weaker sunlight that shines for a shorter time than regions closer to the equator. This will lead to a shorter and less productive growing season. Water supplies will also become more limited as ice caps melt and sea levels rise, allowing salt to infiltrate fresh groundwater. The EPA lists some other possible impacts of climate change on agriculture:
 - Lengthening the growing season in regions with a relatively cool spring and fall.
 - Adversely affecting crops in regions where summer heat already limits production.
 - Increasing soil evaporation rates.
 - Increasing the chances of severe droughts.
 - CO₂ rise helping plant growth but offset by effects of temperature and precipitation changes.

6. It is also important to consider the impact of our current agricultural practices on the environment, and how we can be more sustainable in this field. The students will explore these areas further in the following activities. The first activity will look at how climate change will affect agriculture, and the second will investigate how the food we consume affects climate change.

Activity One: Adapting to Climate Change

1. Break the class into small groups. Have each group select a place in the United States

to establish a hypothetical farm. Ensure that there is considerable variation among the groups (for example, the Midwest, the Southeast, the Pacific Northwest, the Northeast, etc). Ask the students to do research on their area and determine what crops their climate can maintain. Have them look at this Web site for help:

http://www.agclassroom.org/teacher/ag_facts.htm.

2. Next, students should research sustainable agriculture and describe what sustainable practices they could establish on their farms. Some examples include rotating crops to avoid leaching soil nutrients, minimizing greenhouse gas emissions, sustainable irrigation and water use, avoidance of pesticides, and limiting use of fertilizers that pollute groundwater. To help students understand these terms, have the students fill out the worksheet at the end of the lesson plan.

3. Have the students imagine that it is ten years later, and their farms are now being affected by climate change. Depending on the location of the farm, the effects will be different. To make things easier, you may use these simplified rules:
 - Eastern and western coastal areas will experience flooding, especially Florida and other very low-lying areas.
 - Southern coast will experience increased numbers of tropical storms.
 - Temperature will rise several degrees in all locations.
 - Southeast areas will experience a distinct dry season in the winter. Droughts and wildfires will be experienced throughout the Midwest and in California.
 - The Northeast will experience changes in their ecosystem, such as the predominant trees switching from Maple to Oak.
 - Alaska and Canada will experience a longer growing season.

4. Ask students to describe what new challenges are posed to their farm. Is their farm's crop still able to grow under the new conditions? How is it affected by changing temperatures? Changing precipitation? Will climate change affect their income? Will other areas' increased ability to produce crops (such as Canada) affect their farm's profit?

Activity 2: Food and Climate Change

1. Instruct each student to take an inventory of their food and water consumption for two days in their notebook. They should keep record of what foods they eat, how much water they drink, how many times they wash their hands, how long they stay in the shower, how many times they flush the toilet, and any other activity involving food or water consumption.

2. In class or at home, have students examine the amount that they have consumed. To start, they can calculate their totally water usage using the US Geological Survey's Water Usage Questionnaire at <http://ga.water.usgs.gov/edu/sq3.html>.

3. After looking at water intake, it is time to turn to food. Provide the students with some information about the meat industry and its impact on the earth. Some issues to discuss are: deforestation to create pastures and land to grow feed, water and energy needed to slaughter the animals and process the meat, carbon emissions from immense amounts of transportation to get food to the consumer, and soil erosion from overgrazing are all problems. According to a recent report by the [Intergovernmental Panel on Climate Change](#), Agriculture, Forestry, and other land use produce 24% of global greenhouse gas emissions. Much of this is from generating 65% of human-related nitrous oxide (mostly from manure) and 37% of human- induced methane. Both of these are much stronger greenhouse gases than CO₂.

4. With this information in mind, have the students estimate the ecological footprint of their own food consumption for the two recorded days using the table below. You can also assign your students to use the Earth Day Network ecological footprint quiz available at: <http://www.earthday.org/take-action/footprint-calculator/>.

CO₂ equivalent emissions of various foods:

Food	Lbs CO₂/100 Calories
Chicken	0.37
Milk	0.62
Eggs	0.64
Beef (grain fed)	3.04
Pork	1.99
Lamb	5.71
Fish (average value)	1.33
Herring	0.06
Tuna	1.05
Salmon (farmed)	1.07
Shrimp	6.79
Corn	0.02
Soy	0.01
Apple	0.06
Potatoes	0.05
Vegetable (average value)	0.03

5. Have students turn in a two-page document that includes their food and water

consumption inventory and the results of an ecological footprint test. Students should be evaluated based on the depth of their research and the quality of their written report. Students should demonstrate an understanding of the interaction between climate and agriculture and the ways in which climate change will affect this delicate relationship.

Conclusion

Students should now have an understanding of the impact climate change can have on our limited supplies of food and water. They should be aware of the agricultural process and how it fuels climate change, which in turn can reduce the available water supply. Encourage the students to be conscious of their food and water consumption and how their habits can have an impact beyond themselves.

For future information about water resources, go to the USGS Water Education site, <http://ga.water.usgs.gov/edu/mearth.html>.

Name _____

Date _____

Activity One: Adapting to Climate Change

Define the following terms that relate to agriculture and sustainable farming.

1. Organic agriculture: _____

2. Soil salinization: _____

3. Sustainable irrigation: _____

4. Monoculture: _____

5. Crop rotation: _____

6. Pesticides: _____

7. Carbon sequestration: _____

8. Groundwater: _____

On a separate sheet of paper, write two or three paragraphs describing how and why you would incorporate sustainable agricultural practices on your farm.