



Beyond the Watershed: Water Use and Conservation

Lesson: 18

National Science
Education
Standards for
Grades 9-12

Content Standard A: Abilities Necessary to Do Scientific Inquiry

- *Design and conduct scientific investigations.*

Content Standard F: Science in Personal and Social Perspectives: Natural Resources

- *Human populations use resources in the environment in order to maintain and improve their existence. Natural resources have been and will continue to be used to maintain human populations.*

Content Standard F: Science in Personal and Social Perspectives: Environmental Quality

- *Natural ecosystems provide an array of basic processes that affect humans. Those processes include maintenance of the quality of the atmosphere, generation of soils, control of the hydrologic cycle, disposal of wastes, and recycling of nutrients. Humans are changing many of these basic processes, and the changes may be detrimental to humans.*

Content Standard F: Science and Technology in Local, National and Global Challenges

- *Humans have a major effect on other species. For example, the influence of humans on other organisms occurs through land use—which decrease space available to other species—and pollution—which changes the chemical composition of air, soil and water.*

Student Learning Objectives

- 18.1 Describe agricultural water use in the U.S.
- 18.2 Estimate their water consumption and identify ways to conserve water at home.

Teacher Info Table Time

Instruction time for this lesson: 50 minutes to complete the Water by the Numbers activity (18.1). An additional 25-30 minutes is needed if the activity Calculating Your Water Footprint (18.2) is used as a classroom activity instead of homework.

Resources, Tools, Equipment and Supplies

18.1 Describe agricultural water use in the U.S.

Resources: *Slides*

- SW.18.TM.A Percentage of Usage by User Type
- SW.18.TM.B Water Use in U.S.
- SW.18.TM.C Water Use Answers
- SW.18.TM.D Most Water Used by States
- SW.18.TM.E Most Water Used by States Answers
- SW.18.TM.F Water Use for California Foods
- SW.18.TM.G Water Use for California Foods Answers
- A Water Secure World: Vision for Water, Life, and the Environment, Reported in Mittelstaedt, Martin, World Water Use to Soar to Crisis Levels, Study Says, The Globe and Mail, March 14, 2000
- Cadillac Desert by Marc Reisner, Audubon Magazine, Dec. 1999
- Estimated Use of Water in the United States 2005, USGS: <http://pubs.usgs.gov/circ/1344/>
- Implementing the Great Lakes Compact: Wisconsin Conservation and Efficiency Measures Report, UW-Madison Dept. of Urban and Regional Planning, p. 4, accessed March 2010 at <http://urpl.wisc.edu/people/genskow/URPLconservationefficiency2009.pdf>
- Summary of Estimated Water Use in the United States in 2005 (PDF): <http://pubs.usgs.gov/fs/2009/3098/>
- Water and People: <http://ga.water.usgs.gov/edu/hydrology.html#HDR1>
- NRCS website: http://nrcs.usda.gov/wps/portal/nrcs/detailfull/national/energy/&cid=nracs143_23638_document; http://nrcs.usda.gov/internet/fse_documents/nracs143_23630.pdf

**Resources,
Tools, Equipment
and Supplies**

18.1 Equipment

Computer
LCD projector

18.2 Estimate their water consumption and identify ways to conserve water at home.

Resources

- H2O Conserve Water Calculator: http://www.h2oconserve.org/?page_id=503
- Water Q&A: Water Use at Home, USGS: <http://ga.water.usgs.gov/edu/qahome.html>
- Water Sense (water efficient home appliances), U.S. EPA: <http://www.epa.gov/watersense/index.html>

Equipment

Computer
Access to Internet

Homework Preparation for Lesson 19

Resource

- SW.18.AS.Homework: A Primer on Climate Change – One copy for each student

Key Terms

Climate change

Industrial

Irrigation

Public supply

Thermoelectric power

SUMMARY OF CONTENT AND TEACHING STRATEGIES: [BACKGROUND FOR TEACHERS]

[Content: Water and People: <http://ga.water.usgs.gov/edu/hydrology.html#HDR1>]

Five U.S. Geological Survey (USGS) estimates of water use in the United States indicate that about 410 billion gallons per day (Bgal/d) are withdrawn for all uses. This total has varied less than 3 percent since 1985 as withdrawals have stabilized for the two largest uses—thermoelectric power and irrigation. Fresh groundwater withdrawals (83.3 Bgal/d) during 2000 were 14 percent more than during 1985. Fresh surface water withdrawals for 2000 were 262 Bgal/d, varying less than 2 percent since 1985. Please note that water use figures for the U.S. may vary among federal agencies, but it is not important for students to memorize these numbers. What is important is that they realize the magnitude of the amount of water used each day.

INTEREST APPROACH:

In Lesson 8 students made pie charts of different water uses in their county. In this lesson they will expand on that work to look at both state and national water use.

2005 U.S. Geological Survey (USGS) estimates of water use in the United States indicate that about 408 billion gallons per day (Bgal/d) are withdrawn for all uses. The numbers of gallons of water used seems staggering. How could we possibly be using that much water each day?

Yet, much of our water use is hidden. Think about what you had for lunch. How much water was used to create the food? How about to get it to your plate? Guess how much water goes into creating the all-American meal of a hamburger, fries and a soft drink. How much water does it take to grow cotton for a pair of jeans? How about a shirt? What about the car and bicycle you use to get around town? Write the students' guesses on the board.

Now reveal the following information: A hamburger requires water to raise wheat for the bun, to grow hay and corn to feed the cattle and to process the bread and beef. Together with French fries and a soft drink, an all-American meal uses about 1,500 gallons of water--enough to fill a small swimming pool. How about your clothes? To grow cotton for a pair of jeans takes about 400 gallons. A shirt requires about 400 gallons. How do you get to school or to the store? To produce the amount of finished steel in a car has in the past required about 32,000 gallons of water. Similarly, the steel in a 30-pound bicycle required 480 gallons.

OBJECTIVE BY OBJECTIVE:**Activity Outline and Teacher Support Information:**

In Lesson 8 students made pie charts of water use types in their county. In this lesson they will zoom out from that perspective to look at water use in the U.S. in general, both individual use and agricultural use. Then they'll zoom in to look at their personal water use and conservation efforts.

18.1 Describe agricultural water use in the U.S.

2005 U.S. Geological Survey (USGS) estimates of water use in the United States indicate that about 410 billion gallons per day (abbreviated Bgal/d) are withdrawn for all uses. Please note that water use figures for the U.S. may vary among federal agencies, but it not important for students to memorize these numbers. What is important is that they realize the magnitude of the amount of water used each day.

The numbers of gallons of water used seems staggering. How could we possibly be using that much water each day? Show slide SW.18.TM.A – Percentage of Usage by User Type. Remind students that they explored these four major water use types, thermoelectric power, irrigation, public supply, and industrial, in Lesson 8. These four components make a very simple pie chart representing water use in the U.S. Yet, as was demonstrated in our lesson introduction, water use is a very complex thing to measure; many of the ways we use water are hidden. We're often not conscious of the impacts our choices as consumers, homeowners, students or farmers have on water resources.

Note that consumptive use can be an important factor - some water withdrawn is returned to natural stream flows or recharged to groundwater. The National Water Census is trying to get a better handle on consumptive use. Web link to census: <http://water.usgs.gov/wsi/>

Classroom Activity: Water by the Numbers

In this activity, students work in teams to answer quiz questions about water use. The quiz could be set up as a contest, with the team guessing most accurately on all the questions winning five extra points on the evaluation or some other recognition.

Break the class into teams into four teams. Each team should have a piece of paper and pencil to record answers to the quiz. Show slide SW.18.TM.B.

1. How many gallons of water does the average American individual use at home each day?

2. How many gallons of water does the average African family use each day?

Ask each team to write an answer on the paper. Have each team report its guess to the class and write each groups number on the board. Then show the answer on slide SW.18.TM.C. Were the students surprised by the answers? Why or why not? Do they think they each use that much water at home each day? How would they find out?

Now show slide SW.18.TM.D and ask the teams to answer the next set of quiz questions.

3. Which state uses the most freshwater in the U.S.?
4. Name three other states that are listed among the top water users.
5. Which state used the most water for irrigation?

Show slide SW.18.TM.E and have the teams check their answers with those on the slide. Share this information from the USGS Water Use website with students¹:

In 2000, California alone accounted for almost 11 percent of all freshwater used in the United States. After California was Texas, Idaho and Illinois, which together accounted for 28 percent of all fresh water used in the U.S. Most of the water used in California was for crop irrigation. In fact, 22 percent of the entire nation's irrigation water used was in California, which indicates how important irrigated agriculture is there. California is the third largest agricultural economy on the planet. Florida also is a large food producer but because it gets a lot more summer rainfall than the Central Valley of California, there is less need to apply irrigation water.

The three most populated states, California, Texas and New York accounted for 30 percent of all water withdrawn for public-supply uses (for example, a city/county withdrawing water and delivering it to our homes and businesses). Texas, Wyoming and Oklahoma used the most water for mining purposes, and California, Michigan and Florida used the most water for household (domestic) purposes.

Agriculture is a big business in the United States and a lot of water is used to produce our food. In 2000, farmers used water to irrigate about 61,900,000 acres of land. That is about 96,700 square miles, which you can think of as a big, square plot of land about 311 miles on a side. And that is only the land that was irrigated; other land produced crops without the use of irrigation.

As expected, California led the Nation in acres irrigated, about 10,100,000, which was over 16 percent of the national total. Nebraska was next, irrigating about 7,420,000 acres, followed by Texas at about 6,490,000 acres. Agricultural irrigation is much more prevalent in the arid Western United States than in the East. The

¹ Water Q&A: Water use, USGS: <http://ga.water.usgs.gov/edu/qausage.html>

Western U.S. accounts for the majority of irrigation water use. Farmers can use techniques for more efficient irrigation, including drip irrigation and soil moisture driven irrigation schedules.

Growing our food is a very water intensive endeavor. Show slide SW.18.F. This is a list of estimates for the amount of water needed to produce certain food products in California. Ask each team to guess how much water is required to produce one pound of each food item in the list.

Water required to produce one pound (lb.) of California foods:²

- 1 lb. lettuce: 23 gallons
- 1 lb. tomatoes: 24 gallons
- 1 lb. wheat: 25 gallon
- 1 lb. carrots: 33 gallons
- 1 lb. apples: 49 gallons
- 1 lb. chicken: 815 gallons
- 1 lb. pork: 1,630 gallons
- 1 lb. beef: 5,214 gallons

When the teams have finished making the guestimates, show the answers on slide SW.18.TM.G. Are the students surprised by the answers? Ask students to imagine what the water investment is for producing a pound of tomatoes for market and consider:

- Irrigation
- Washing the tomatoes after harvesting, etc.

Now ask students to imagine what the water investment is for producing a pound of beef for market and consider:

- Irrigation for growing the grain to feed the cattle
- Watering the cattle
- Water uses at the slaughter house

² [Source: Soil and Water specialists, Univ. of Calif. Agricultural Extension, working with livestock farm advisors Schulbach, Herb , et. al., Soil and Water, No. 38, Fall 1978, retrieved from http://www.foodrevolution.org/facts_quotes.htm#w]

It is easy to see why animal production would use more water than producing most fruits or vegetables. If we want to continue to enjoy a wide variety of foods grown within the U.S., producers need to be more creative in developing water saving technologies.

18.2. Estimate their water consumption and identify ways to conserve water at home.

Classroom or Homework Activity: Calculating Your Water Footprint

Using the interactive H2O Conserve website tool, What Is Your Water Footprint? students will calculate their home water use. They can do this as a classroom activity or as a homework activity.

Students will start at the H2O Conserve Water Calculator page: http://www.h2oconserve.org/?page_id=503

They should follow the site's prompts to calculate their home water use. When they've completed the survey, the calculator will show their answers and offer some tips on conservation measures they can take to reduce their footprint. Ask students to write down three of those suggestions to share with the class. They should also be encouraged to share the results and conservation tips with family members.

What are some things students could do at home to save water? (Sample acceptable answer: use water-efficient appliances, low-flow water fixtures in showers, and water-saving toilets; only run dishwashers or clothes washers when they're full; water lawns at night to reduce evaporation or replace grass with native plants requiring less watering.)

It may be difficult for students who live in areas with sufficient water supplies and rainfall to understand why they should conserve water. Facilitate a classroom discussion of other factors communities need to consider when thinking about water conservation and source water protection.

For example:

Public drinking water suppliers in most communities have to treat all water, even if the water is used for flushing toilets or watering the lawn.

Increasing demands on water supplies or a decrease in supply can create conflicts between neighbors, urban/suburban and agricultural users or between states.

REVIEW / SUMMARY:

Respond to the following questions in your journal:

- What fact about agricultural water use surprised you the most?
- How do you think our state/county compares with the national averages for water use? What do you think accounts for those differences?
- Did any of the details about agricultural water use impact decisions you might make about your diet? Explain.
- List five changes you can make to reduce your water footprint in your home.
- Write a short paragraph that you could use to convince other members of your household to make changes to reduce your total household water footprint.

APPLICATION:**SW.18.AS.Homework****A Primer on Climate Change**

In Lesson 19 students will learn the basics about climate change and possible impacts on agriculture and source water resources. This homework reading assignment is designed to prepare them for Lesson 19 activities. Students will need access to a computer with an Internet connection in order to complete the assignment. Each student will also need a copy of SW.18.AS.Homework: A Primer on Climate Change, which provides homework directions.

EVALUATION AND ANSWERS:**SW.18.ASSESS**

True or False

- _____ 1. It is estimated we use about 410 billion gallons of water per day in the U.S.
- _____ 2. Florida uses the most water for irrigation of all the U.S. states.
- _____ 3. Generally it takes more water to produce a pound of vegetables than a pound of meat.
- _____ 4. All of the following are ways to conserve water at home:
- a. Use water-efficient appliances
 - b. Install low-flow water fixtures in showers
 - c. Install water-saving toilets
 - d. Only run dishwashers or clothes washers when they're full

Note: Consumptive use can be an important factor - some water withdrawn is returned to natural stream flows or recharged to groundwater. The National Water Census is trying to get a better handle on consumptive use. Web link to census: <http://water.usgs.gov/wsi/>

Answers to SW.18.ASSESS

True or False

- TRUE 1. U.S. Geological Survey (USGS) estimates of water use in the United States indicate that about 410 billion gallons per day (Bgal/d) are withdrawn for all uses
- FALSE 2. Florida uses the most water for irrigation of all the U.S. states.
- FALSE 3. Generally it takes more water to produce a pound of meat than a pound of vegetables
- TRUE 4. All of the following are ways to conserve water at home:
- a. use water-efficient appliances
 - b. install low-flow water fixtures in showers
 - c. install water-saving toilets
 - d. only run dishwashers or clothes washers when they're full

ACTIVITY WORKSHEET(S) – AS NEEDED:**SW.18.AS.Homework****A Primer on Climate Change**

You will need a computer with Internet access to complete this assignment.

In this activity you will explore sections of the U.S. EPA's A Student's Guide to Global Climate Change to learn or review basic climate change information. Start by going to this page:

<http://www.epa.gov/climatechange/students/index.html>

Spend as much time as you'd like exploring this site but make sure you read through the following pages. Make sure you click on the bulleted links on these pages.

Learn the Basics (Green tab at top of page)

- Learn more about the climate.
- Find out how and why the climate is changing.
- Learn how the climate changed in the past.

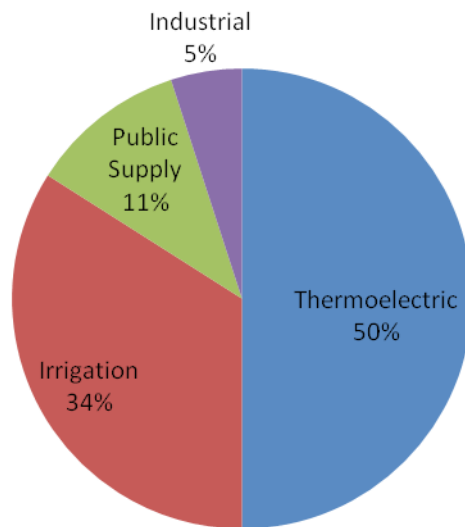
See the Impacts (Orange tab at top of page)

- Learn about the changes happening in the Earth's climate system now and the changes expected in the future.
- Find out how these changes will affect people and the environment.

POWERPOINT SLIDES – AS NEEDED:

SW.18.TM.A

Percentage of Usage by User Type



Note: Consumptive use can be an important factor - some water withdrawn is returned to natural stream flows or recharged to groundwater. The National Water Census is trying to get a better handle on consumptive use. Web link to census: <http://water.usgs.gov/wsi/>

SW.18.TM.B

Water Use in U.S.

1. How many gallons of water does the average American individual use at home each day?
2. How many gallons of water does the average African family use each day?

SW.18.TM.C

Water Use in U.S.

1. How many gallons of water does the average American individual use at home each day?

About 100-176 gallons

2. How many gallons of water does the average African family use each day?

About 5 gallons

SW.18.TM.D

Most Water Used by States

3. Which state uses the most freshwater in the U.S.?
4. Name three other states that are listed among the top water users.
5. Which state used the most water for irrigation?

SW.18.TM.E

Most Water Used by States Answers

3. Which state uses the most freshwater in the U.S.?

California

4. Name three other states that are listed among the top water users.

Texas, Idaho and Illinois

5. Which state used the most water for irrigation?

California

SW.18.TM.F

Water required to produce one pound (lb.) of California foods:³

- 1 lb. lettuce:
- 1 lb. tomatoes:
- 1 lb. wheat:
- 1 lb. carrots:
- 1 lb. apples:
- 1 lb. chicken:
- 1 lb. pork:
- 1 lb. beef:

3

[Source: Soil and Water specialists, Univ. of Calif. Agricultural Extension, working with livestock farm advisors Schulbach, Herb , et. al., Soil and Water, No. 38, Fall 1978, retrieved from http://www.foodrevolution.org/facts_quotes.htm#w]

SW.18.TM.G

Water required to produce one pound (lb.) of California foods:

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