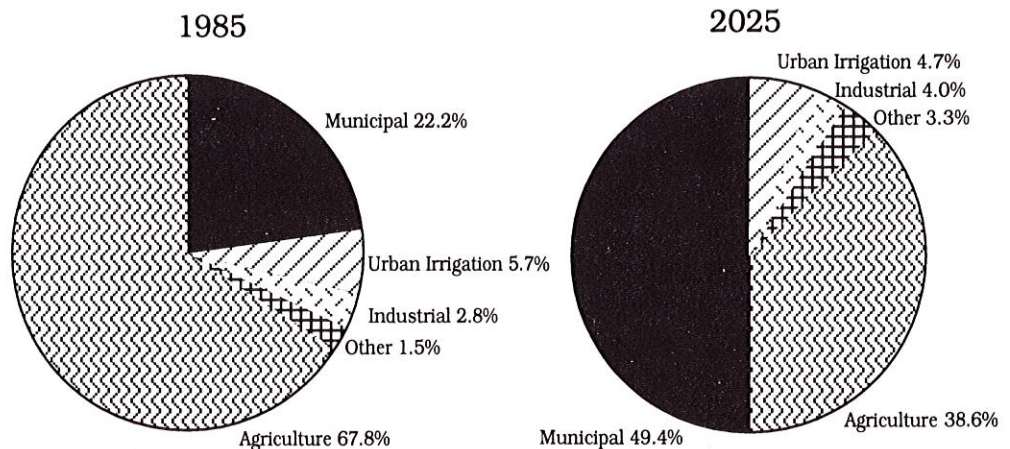# THE WATER THEY USE

Objectives

Students will:

- hypothesize about the amount of water required to produce a variety of products they enjoy.
- analyze this information and apply it to their own lives.

Background

Agriculture, industry, municipalities, and other users place demands on the limited water available in the Phoenix area. Water demands by these users for 1985 and projected for 2025 are provided in the following graphs.

1985

Municipal 22.2%

Urban Irrigation 5.7%

Industrial 2.8%

Other 1.5%

Agriculture 67.8%

2025

Urban Irrigation 4.7%

Industrial 4.0%

Other 3.3%

Municipal 49.4%

Agriculture 38.6%

Adapted from Phoenix AMA Second Management Plan

Agricultural water demands include those for preparing and irrigating soils and producing crops. For instructional purposes both

Overview

Students participate in a matching game that illustrates the demands placed on our water resources by agriculture, industry, municipalities and others. The students should see that the "they" in activity title, should be replaced by "we," for as community members we rely on "products" from each of those water users.

Indian and non-Indian agricultural water uses have been combined in the graphs. The primary **industrial water demands** of business, trade, or manufacturing in the Phoenix area are for turf-related facilities (like golf courses), sand and gravel operations, dairies, and electric power generating facilities that use water from their own wells.

Municipal water demands are made by the people who live in and visit the cities and towns of the Phoenix area. At our homes and schools we demand water for many of our daily activities. For instance, the average evaporative cooler consumes fifty gallons of water daily. The municipal classification also includes water used by business and industry that is purchased from municipal utilities (i.e., cities, towns and private water companies). Also, Salt River Project and a few other water providers, such as the Arcadia Water Company and Maricopa County Municipal Water Conservation District (MCMWCD), meet **urban irrigation demands** by providing untreated water for landscape and small pasture watering through distribution systems completely separate from the residential water delivery system.

In the past, Arizona's economic development was based primarily on the four Cs: cattle, copper, citrus, and cotton. In the Sonoran Desert, each of these industries must depend on water to get their product to the marketplace.

Cattle. Approximately 5000 gallons (nearly 19000 liters) of water are required to produce one pound of beef (or 1250 gallons/4750 liters for a quarter-pounder).

Copper. The volume of water required to produce one pound of new copper from copper-bearing rock depends on the process. Seventy percent of the copper produced in Arizona in 1992 came from a milling process that requires about 25 gallons (95 liters) of water to yield a pound of copper. In 1992 the other 30% of Arizona copper came from a process known as SX/EW (or Solvent Extraction Electrowinning) which requires 125 gallons of water (473 liters) to yield a pound of copper. The average new home contains about 500 pounds of copper pipe and wiring.

Citrus. One orange can require 100 gallons (378.5 liters) of water to reach your table.

Cotton. About 1800 gallons (6813 liters) of water is needed to produce the cotton in a pair of blue jeans (which weigh about 1.5 pounds). Thus, about 1200 gallons of water are needed to produce one pound of cotton.

Students will be amazed at the large quantities of water required to produce their favorite foods, manufacture their transportation, and keep their playing fields green. During this activity they will have an opportunity to pair water uses with water quantities to learn more about the water required to maintain their lifestyles.

Materials

For each team of four students:
- business size envelope
- WATER VOLUMES LIST
- WATER USES LIST
Prepare by cutting into separate pieces, mixing thoroughly and storing in envelopes with folded WATER VOLUMES LIST.
- CLUES TO WATER USES; cut so two team members have clues
- correct answers, optional; can also be discussed or displayed
- glue, tape, or rubber cement, optional. Students may make a permanent record of their hypotheses by gluing or taping the cards side-by-side, and drawing lines between any "guesses" which may be incorrect.

Procedure

Activity adapted from The Nevada Science Project

1. Remind students that they could not survive without water. Let them know: *"More than two-thirds (66%) of each of your bodies is water. Although adult humans have lived for up to 60 days without food, humans have lived only five days without water. To maintain life, your body needs water. 83% of our blood is made up of water; 70% of our brain is water. Water helps us digest food and keep cool. Human beings use about two and a half quarts (2 liters) of water on an average day for breathing, perspiration and excretion. Every day we need to ingest at least 2 1/2 quarts or 2 liters of water through the foods we eat and the liquids we drink. Water is also necessary to make most of the products and carry out most of the actions that are important to our existence. Cities and towns need water to enable their residents to live their lives. To get their products to the market, both agriculture and industry also need water. In some cases, lots of water."*

2. Students might remember that 10 minutes in a shower equipped with a regular shower head can use 50 gallons (190 liters) of water. In this activity each team will be given a set of cards on which activities and water usages are described. They must match them with the amount of water they think is needed for each activity. Distribute the envelopes to each team.

3. Give students at least ten minutes to discuss volumes and attempt to match lists. Then distribute CLUES TO WATER USES.

4. When all teams have matched pairs, discuss the findings. Which water usage volumes were the most surprising to the students? Could people in Phoenix continue living as they do today without water being used by agriculture, industry and municipalities? What do students know about ways agricultural and manufacturing businesses are reducing their water needs?

5. In teams, have students calculate how much water would be required to produce the following Sunday breakfast for you: fresh-squeezed orange juice (four oranges), two pieces of whole wheat bread with one ounce of margarine melted on each, three ounces of cereal with eight ounces of milk, and the Sunday newspaper. [Answer: (4x100)+(2x120)+(2x92)+(3x18)+130+280 = 1288 gallons/4876 liters.]

6. Have students select a menu or calculate the quantity of water required to feed everyone on their team a hamburger, French fries, and a soda.

7. Encourage discussion of water users with this question that has no right answer: *"In terms of the quality of your life, which water use is most important to you: agricultural, industrial, irrigation, or municipal?"*

Extensions

1. Make paper from recycled paper, dryer lint and other plant fibers to illustrate the volume of water required for paper making. For instructions see **Project Learning Tree**, 1993, "Make Your Own Paper," pp.176-9. A more comprehensive study is available in AAAS's **Science Resources for School.**

2. Share the 1985 and projected 2025 water use figures, focusing on the changes in categories. Why is agricultural water use projected to decrease over those 40 years? Why is municipal use projected to increase? Have students investigate the current and future status of the four Cs (cattle, copper, citrus, and cotton) in Arizona.

3. Determine the volume of water in foods. All food contains water. Seeds are the driest, between 5-10% water. Watermelon is nearly all water, 98% or higher. Weigh a variety of foods as you would eat them. Then dehydrate using solar dehydrators students construct themselves, or commercial electric dehydrators. Weigh foods when dry. The difference represents the volume of water in the foods. Calculate percentages.

Evaluation

1. Estimate the amount of water required to produce the following products. Be sure to identify the unit of measurement.

PRODUCTS	WATER REQUIRED TO PRODUCE
pair of blue jeans	_____
1 pound of hamburger	_____
1 apple	_____
Sunday newspaper	_____
steel for a car	_____

2. Which of the following water uses is most important to you: agricultural, industrial, irrigation, or municipal? Tell why.

Resources

American Association for the Advancement of Science, **Science Resources for School** "Doing Science", Vol. 2, No.3. Washington, D.C.

Arizona Department of Water Resources. 1991. **Second Management Plan 1990-2000: Phoenix Active Management Area.**

Dale, J., P. Corsentino, R. Brickell. 1992. **The Story of Drinking Water, Teacher's Guide**, Third Edition. Denver, CO: American Water Works Association.

Nevada Science Project, High School Edition: **Water Unit 1991.**

Phelps Dodge Morenci Inc. **Solvent Extraction Electrowinning (SX/EW) Plant: The Largest SX/EW Plant in the United States.**

Ridinger, D., President of Arizona Mining Association. Personal correspondence, 1993.

University of Arizona. 1994. **Arizona WET: Water Education for Teachers**. Tucson: College of Agriculture, Water Resources Research Center.

ANSWERS

Note: discrepancies in conversion for English to Metric units are due to rounding error

1. 32,000 g./121,120 l - one ton of steel
2. 20,000 or more g./75,700 l - swimming pool
3. 7,000 g./26,495 l - tires
4. 5000 gallons/18925 liters - one pound of beef
5. 1800 g./6813 l - blue jeans
6. 1250 g./4731 l - quarter-pound hamburger
7. 700 g./2650 l - cooling water for electric power plant
8. 408 g./1544 l - chicken
9. 280 g./1060 l - Sunday newspaper
10. 130 g./ 492 l - milk
11. 125 g./473 l - copper wire or pipe *(using SX/EW process)*
12. 120 g./454 l - whole wheat bread
13. 100 g./379 l - watermelon
14. 100 g./379 l - orange
15. 92 g./348 l - margarine
16. 85 g./322 l - green beans
17. 61 g./231 l - corn
18. 47 g./178 l - apple
19. 24 g./91 l - plastic
20. 24 g./91 l - potato
21. 24 g./91 l - lettuce
22. 18 g./68 l - cereal
23. 10 g./38 l - cola soft drink
24. 6 g./23 l - French fries
25. 5 g./19 l - lumber
26. 3 g./11 l - tomato

WATER VOLUMES LIST

1. 32,000 gallons/121,120 liters	
2. 20,000 + gallons/75,000 liters	
3. 7,000 gallons/26,495 liters	
4. 5000 gallons/18,925 liters	
5. 1800 gallons/6813 liters	
6. 1250 gallons/4731 liters	
7. 700 gallons/2650 liters	
8. 408 gallons/1544 liters	
9. 280 gallons/1060 liters	
10. 130 gallons/492 liters	
11. 125 gallons/473 liters	
12. 120 gallons/454 liters	
13. 100 gallons/379 liters	
14. 100 gallons/379 liters	
15. 92 gallons/348 liters	
16. 85 gallons/322 liters	
17. 61 gallons/231 liters	
18. 47 gallons/178 liters	
19. 24 gallons/91 liters	
20. 24 gallons/91 liters	
21. 24 gallons/91 liters	
22. 18 gallons/68 liters	
23. 10 gallons/38 liters	
24. 6 gallons/23 liters	
25. 5 gallons/19 liters	
26. 3 gallons/11 liters	

WATER USES LIST

MANUFACTURE 1 TON OF FINISHED STEEL FOR 1 CAR
MAKE 1 BOARD FOOT OF LUMBER
PRODUCE 1 SLICE OF WHEAT BREAD
PRODUCE 1 CUP OF LETTUCE
PRODUCE 8 OZ. OF MILK
PRODUCE 1 SERVING OF GREEN BEANS
PRODUCE 1 APPLE
PRODUCE 1 POTATO
PRODUCE 1 SMALL SERVING OF FRENCH FRIES
PRODUCE 1 TOMATO
PRODUCE 1 - 12 OZ. CAN COLA SOFT DRINK
PRODUCE 1 POUND OF BEEF
PRODUCE A QUARTER-POUND HAMBURGER
COOLING WATER FOR ELECTRIC POWER: 1 PERSON/DAY
PRODUCE THE SUNDAY NEWSPAPER
PRODUCE 1 POUND OF COPPER WIRE OR PIPE
FILL A SWIMMING POOL
PRODUCE 1 ORANGE
PRODUCE 2 PIECES OF CHICKEN
PRODUCE 1 OUNCE OF MARGARINE
PRODUCE 1 OUNCE OF CEREAL
MAKE 1 POUND OF PLASTIC
PRODUCE COTTON FOR 1 PAIR OF BLUE JEANS
PRODUCE 1 EAR OF CORN
PRODUCE 1 WATERMELON
PRODUCE TIRES FOR A CAR

CLUES TO WATER USES

THE WATER REQUIRED FOR:	IS	THE WATER REQUIRED FOR:
1 tire	=	electric power cooling water for 10 people
1 ton of steel	=	3200 cans of cola
8 oz. of milk	>	1 slice of wheat bread
1 tomato	<	1 small serving of French fries
1 ounce of cereal	1% of	cotton for 1 pair blue jeans
1 ear of corn	about 10 times >	1 small serving of French fries
1 serving of green beans	<	1 orange
1 watermelon	=	1 orange
1 cup of lettuce	=	1 potato
1 cup of lettuce	<	1 apple
1 potato	>	1 can of cola
1 orange	<	1 slice of wheat bread

THE WATER REQUIRED FOR:	IS	THE WATER REQUIRED FOR:
1 tomato	2.5%	1 slice of wheat bread
1 potato	=	1 pound of plastic
2 pieces of chicken	about 1/3	a quarter pound hamburger
the Sunday newspaper	56 times	1 board foot of lumber
1 small serving of French fries	<	1 can of cola
1 board foot of lumber	5%	1 orange
1 pound of beef	1/4	a swimming pool
1 apple	<	1 ear of corn
a quarter pound hamburger	10 times	1 pound of copper wire or pipe
8 oz. of milk	>	1 watermelon
1 can of cola	<	1 ounce of cereal
1 ounce of margarine	<	1 slice of wheat bread