Water Conservation

Exploring Water Use and Water Conservation Techniques

Description

This activity expands students' understanding of one proposed action in response to climate change presented in Streams and Steam: water conservation. Students calculate their weekly water use and compare it to the average American, explore two models of water conservation (land contouring and rooftop rainwater harvesting), and design a solution that reduces their water consumption by 25%.

Problem

Due to increased temperatures, increased variability in precipitation patterns, and increasing population in New Mexico, it is anticipated that water availability for domestic, commercial, and agricultural use will decline.

Design Challenge

Design a plan to reduce your personal weekly water use by 25%.

Objectives

Students will:

- Calculate their weekly water consumption
- Use models to evaluate and understand water conservation techniques
- Apply information presented in models to design a solution that reduces personal water use

Grade Level

5 – 8

Time

1 Hour

Materials

See page 2.

Developed by the Asombro Institute for Science Education (www.asombro.org)

Materials

- *Water Conservation* handout [1 per student]
- PowerPoint presentation
- Computer and projector*
- Station task cards [3 per station, 6 total]
- Design Challenge solution cards [9 cards per set; 6 sets]
- Land contouring station [materials for 3 stations]
    - Metal cake pans [3]
    - Kinetic sand
    - Small vial with 20 blue beads [3]
    - Ruler [3]
    - Cardboard pieces for flattening sand [3]
- Rooftop Rainwater Harvesting station [materials for 3 stations]
    - Bath towels [3]
    - Large clear bin [3]
    - Mini-crate with attachments [3]
    - Binder clip [6]
    - Cistern [3]
    - Roof with attachments [3]
    - Watering can [3]
    - 500-ml beaker [3]
    - ½-gallon jug of water, if water is not available in your classroom [3]*
    - Calculators*

* Not included in kit

Background

Climate change, specifically higher average temperatures, is predicted to have multiple effects on New Mexico's water resources. Warmer temperatures result in reduced snowpack; snow will fall for a shorter season, and the snow that does fall will melt earlier in the spring. Warmer temperatures will also increase evaporation during warm seasons (spring and summer). This increased evaporation will lead to reduced soil moisture, which impacts plants and animals. Another predicted effect of warmer temperatures is more extreme weather events – both more frequent and intense droughts as well as more frequent floods.

While warmer temperatures are predicted for all parts of New Mexico, predictions about total precipitation amounts vary for different regions. As we saw in Climate Data Jam, most counties in New Mexico will see only modest changes in annual precipitation, although there will be changes in when precipitation falls. However, counties in the northeastern corner of the state can expect precipitation decreases of 7 mm to 33 mm per year.

Changes in New Mexico water resources will profoundly impact the people and environments of this semi-arid state. For example, many state water decisions are constrained by the Rio Grande Compact, an agreement signed in 1938 by New Mexico, Colorado, and Texas, which sets standards for the amount of water that New Mexico must deliver to Texas via the Rio Grande River. As increasing temperatures reduce snowpack and alter the timing of streamflow, leading to more frequent and prolonged droughts, New Mexico's ability to honor the Rio Grande Compact while also providing sufficient water resources for New Mexicans will be challenged.

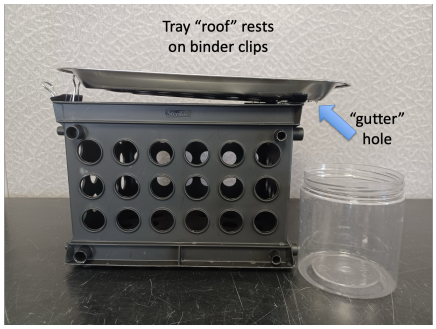
New Mexicans can contribute to preserving our state's precious water resources through both small and large actions. This activity introduces students to two old but less well-known water conservation techniques and prompts students to design a solution to reduce their personal water use.

Tips for Entire Class Participation

- There are supplies to set up three identical stations for each activity (six stations total). Divide students into six groups when it is time to rotate through the stations.
- When possible, we recommend setting up stations on tables where students can stand all around the set-up rather than on a table or lab bench against a wall. This arrangement allows more students to have a good view and easy access to the station.

Preparation

1. Plan to divide students into six groups for the activity stations.
2. If no sinks are available in the classroom, fill ½-gallon jugs with water for the rooftop rainwater harvesting stations.
3. Set up three land contouring stations:
    a. Set out baking pans and evenly distribute two pounds of kinetic sand into each.
    b. Place one ruler, a jar of 20 beads, and one piece of cardboard near each station.
    c. Set out the station task card.
4. Set up three rooftop rainwater harvesting stations (see photos on Slide 10):
    a. Spread out a towel at each station. Do all of the following on top of the towel.
    b. Separate the three clear plastic bins – detach lids.
    c. Place rooftop on top of the mini-crate. The roof will be off-center with the gutter hole over the front corner of the crate. The roof Velcro should attach to the front edge of the crate with the back of the rooftop leaning against the binder clips (see figure on right).
    d. Place mini-crate with attached roof into the large clear bin.



    e. If doing this lesson with multiple classes in a row, it can be helpful to place a brick or rock inside the mini crate to keep it from floating around. For multiple classes, it can also conserve water to use a pitcher or clean milk bottle for students to use for resetting.
    f. Position the cistern container under the gutter hole toward the front of the mini-crate. Adjust the cistern so that the gutter hole hangs over the opening of the cistern.
    g. The crate, rooftop, and cistern should be in place for students to run the model.
    h. Place the watering can and 500-ml beaker near the station.
    i. Have a ½-gallon jug of water filled and near the bin (if no sink is nearby).
    j. Set out the station task card.
5. Set up computer, projector, and PowerPoint presentation

Teaching Guide

Introduction: Are You a Water Wizard? (~15 minutes)

1. Slide 1: Water Conservation – New Mexico Climate Champions
2. Slide 2: Take a few moments at the beginning of this activity to remind students of the second component of New Mexico Climate Champions: designing solutions to problems related to climate change. During our first four activities, we made sense of the phenomenon observed in Climate Data Jam: in New Mexico, temperatures are expected to rise, and precipitation patterns are expected to increase in variability. Now that we understand why this phenomenon is occurring and the effects of this phenomenon, we will explore solutions to adapt to these changes.

3. Introduce the problem that students will address with their design solutions in both the Water Conservation activity and their engineering projects: Due to increased temperatures, increased variability in precipitation patterns, and increasing population in New Mexico, it is anticipated that water availability for domestic, commercial, and agricultural use will decline.
4. The remainder of the New Mexico Climate Champions module will be focused on designing solutions to address this problem. To better understand the problem and possible solutions, students will complete a water use survey to approximate their weekly water use and compare it to the average American.
5. Slide 3: Are you a water wizard? Tell students that they will be calculating the amount of water they use in a week by completing the Water Use Table on page 1 of the handout.
    a. First, have students estimate the number of times per week they do each of the activities listed.
    b. This estimate serves to give students a general idea of their water use. If students do not know exact numbers for each week, encourage them to make an estimate.
    c. After students estimate how frequently they do each activity, they multiply these numbers by the gallons of water each activity uses. Students will likely need calculators.
    d. You can do the first activity (bath) together. For example, if you take an average of two baths per week, you enter "2" in the "Number of Times Per Week" column. Then, you multiply this by the Water Use (gallons) of 35 gallons per bath to come up with 70 gallons of Total Weekly Use for baths. Enter 70 in the final column of the Water Use Table in the Bath row. If students don't ever take baths, this row will show 0 gallons.
    e. Students add the total weekly water use for all activities to determine how much water they use in a week.
    f. Discuss students' results as a class. Were they surprised by their water use? Which activity used more or less water than expected?
6. Slide 4: The average American uses 700 gallons of water per week. Ask students to share how their water consumption compares to the average American.
7. Slide 5: Explain the design challenge that students will complete at the end of this activity – to design a plan to reduce their personal weekly water use by 25%. Have students calculate 25% of their personal water use using the equation provided on page 1 of the handout. In the following section, we will explore methods that could be part of students' water conservation plans.

Activity Stations (~20 minutes)

1. Slide 6: Explain to students that they will explore two different water conservation methods by moving through two stations: land contouring and rooftop rainwater harvesting. Students will have 6 minutes at each station to interact with the model and to complete the corresponding section of the handout. Help students recognize that many proposed water conservation methods are not new technologies but rather a reintroduction of historical principles in water conservation. The methods introduced in this activity were practiced before the development of modern irrigation technologies. Encourage students to consider if and how each of these methods could be applied to reduce their personal water use as they move through the stations. Explain that each of these will be options to consider when designing their plan.
2. Slide 7: Land contouring is creating basins that collect and absorb runoff from rooftops, sidewalks, and streets. Terraced fields and other land-contouring techniques have been used throughout wet and dry areas of Asia, North and South America, Africa, and Europe for generations. Perhaps one of the most commonly known methods of land contouring is terracing, when sloped land has flat platforms, resembling steps cut into it. These are used to reduce soil runoff and capture water and are widely used when planting rice. In New Mexico, the Zuni people have used waffle gardens to retain moisture. Waffle gardens are ground-level beds with berms of soil around them to capture and hold water.

3. Slide 8: Students will model rain collection through land contouring by observing how water gathers in specific places due to the intentional shaping of the land. In this model, the kinetic sand represents the land, the beads represent water, and the tilt of the pan represents a hillside that water flows down. Emphasize to students that a task card at each station gives step-by-step instructions for completing each station. Here are the instructions from the task card:

> 1) Turn to page 2 on your handout.
> 2) Look at images of Berm 'n' Basin (Image 1) and Boomerang Berms (Image 2), and choose one type of land contouring to test. Circle your choice in the table.
> 3) Form the kinetic sand to model your chosen land contour. Use cardboard to smooth out other bumps in surface.
> 4) Place 20 beads (representing water) on top of the sand, as seen in Image 3. Twenty beads are already counted for you.
> 5) Have one student hold the ruler vertically next to the end of the pan with the beads.
> 6) Slowly lift the end of the baking pan with the beads until the top edge of the pan is 6 inches in the air. Hold for 10 seconds.
> 7) Slowly place pan back on table. Count the beads that rolled to the bottom of the pan and record this number in the table.
> 8) Put 20 beads back into the jar and place the lid on the jar.
> 9) Flatten sand back into the center of the pan with cardboard.
> 10) Answer question 2 on your handout.

4. Walk students through the control trial as a whole-class demonstration. Using the task card, students will run one trial at this station, making a land contour of their choice. Follow the instructions below to complete the control trial for the class.
    a. Flatten kinetic sand. Use cardboard to smooth out surface.
    b. Place 20 beads (representing water) on top of the sand at one end of the pan. Fifty beads are already counted for you in the vial.
    c. Hold the ruler vertically next to the end of the pan with the beads. Slowly lift the end of the baking pan with the beads until the top edge of the pan is 6 inches in the air. Hold for 10 seconds. Emphasize the slow lift and tilt of the pan as you demonstrate.
    d. Count the beads that roll to the bottom of the pan.
5. Have students fill out the Control (no land contouring) row of the table in the Land Contouring section of the handout. Students write down the number of beads that rolled to the bottom.
6. Slide 9: Rooftop rainwater harvesting is a method of collecting the rainwater that falls on a rooftop by draining it into a barrel or cistern to store for later use. Collecting and storing rainwater goes as far back as the first human settlements in India in the Indus Valley. Evidence of rainwater harvesting systems has been found in writings and reservoirs, wells, and other small structures to hold water. In New Mexico, the Acoma Pueblo (the oldest continually habited community in North America) has been collecting rainwater in natural cisterns since 1150 CE (i.e., for nearly 900 years). The cisterns are natural rock pools that have been modified with bricks and stones. Collected rainwater is used for building and cleaning.
7. Rooftop rainwater harvesting is beginning to take hold all over the world in light of climate change. It's even taking place right here in New Mexico. For example, the Asombro Institute for Science Education installed a 500-gallon rainwater harvesting tank at their Chihuahuan Desert Nature Park in Las Cruces. Water that falls on the roof of the storage building drains into a gutter system that directs the water into the storage tank. The water can later be used to water plants, mix concrete, and for other uses.
8. Slide 10: Students will explore a model rooftop rainwater harvesting system. In the model, the large bin represents the property, the crate represents the house, the rooftop represents the roof of

the house, the plastic container represents a cistern, and the water represents precipitation. Here are the instructions from the task card:

1) Turn to page 2 on your handout.
2) Examine the "roof" and make sure that the water will flow into the cistern. See figure 1.
3) Measure 500 mL of water and pour it into the watering can.
4) Slowly pour the contents of the watering can over the bin. Distribute the water evenly around the bin and watch as the water flows off the roof into the cistern.
5) Once the "rain" has stopped, carefully remove the cistern from the bin.
6) Measure the water that was collected in the cistern using the beaker. Record your results in question 2.
7) Calculate the percentage of total rainwater harvested in the cistern, and record this value in the table in question 2.
8) Empty the contents of the beaker. Place the cistern back into the bracket on the crate.
9) Respond to questions 3 and 4 on your handout.

9. Have students make a prediction on question 1 of the Rooftop Rainwater Harvesting section on the handout. What percentage of the rainwater will be collected in the cistern?
10. Slide 11: Display this slide while students are moving through the stations. When students have completed both stations, take a few moments to review the results of the models. Ask students to share how contouring the land affected the amount of water runoff in the land contouring model. Ask students how much water their rooftop rainwater harvesting system was able to capture. Was it more or less than they predicted?

Design a Solution (~25 minutes)

1. Have students respond to Design Challenge question 1 on the handout. Encourage students to reflect on the previous activities where we investigated climate change in NM and have them make an argument for water conservation.
2. Slide 12: Introduce the design challenge for this activity: design a plan to reduce weekly water use by 25%. Have students turn to Design Challenge question 2.
3. Students will select between nine water-saving options that vary by cost and amount of water saved. The challenge is to design a feasible plan (one they could implement realistically in their home) directly related to their personal water use survey, which reduces their use by 25%. For example, if a student "Waters a Small Lawn" as part of their weekly water use, they may select strategies to reduce water use related to lawn watering. However, suppose a student did not initially report lawn watering in their weekly water use. In that case, they must select other ways to reduce that relate directly to their reported use, such as using a bucket to catch cold shower water or installing a water-efficient dishwasher.
4. Remind students they have already calculated 25% of their weekly water use. Students should reference this quantity on page 1 of the handout and write it at the top of the table on page 3.
5. Give each group of students a pack of solution cards. Students can share the pack of cards in their group as they develop their personal water savings plan. These cards suggest eight different ways students can reduce their water use and how much water could be saved with each method. Each card suggests which activities from the water use survey the method addresses. For example, the card "Install a Rooftop Rainwater Harvesting System" can lessen the water demand for watering a small lawn and/or flushing toilets by approximately 70 gallons per week.
6. From these cards, students select options that could reduce their personal use. As they choose methods they could personally implement, students should record them in the table on page 3 of the handout in the "Action" column. Next, students will identify which activity from the water survey this action alleviates. Using the information on the solution cards, students calculate how

much water could be saved in one week using this method. The goal for students is to find a combination of feasible actions that meet or exceed 25% of their personal water use from the survey on page 1 of the handout.

7. Have students share their water conservation plans in small groups or with the class. Make a note of how different people found the practices helpful depending on how students use water in their homes.
8. Discuss challenges that could arise when using water conservation practices. Ask students to reflect on their personal plan to reduce water use and to consider both the challenges and the straightforward aspects of water conservation. Have students respond to question 3 on page 3 of the handout.

Extension

1. Give students a budget for their solution design challenge, we suggest $5,000. Solution cards include the cost of implementing each solution.
2. Have students go back to their Water Use Table on page 1 of the handout. The first five activities on this list (shaded grey) produce greywater that could be recycled and used again. Have students calculate how much greywater they produce. Ask them to think about ways this water could be used around their homes.