What are the Methods Used to Irrigate Desert Land?

Grade Levels: 3-5

Purpose:
Students will understand the different irrigation methods farmers use to grow crops, technology that maximizes water use and conservation practices used to maintain and improve water quality.

Materials:

Interest Approach
- Umbrella
- Towel
- Spray bottle of water

Activity 1
- Two pieces of cloth or 2 paper towel sheets
- 1 zip lock bag
- Small tray

Activity 2
- 1 large container for holding water
- 2 smaller containers to collect water
- Small paper cup per student
- Water

Activity 3
- Handout: Irrigation methods cards, cut out 1 set per small group
- Worksheet: Irrigation Methods Venn Diagram
- Videos & worksheets on irrigation tools and careers.

Activity 4
- Assorted construction materials: straws, toothpicks, cups, plastic bottles, cardboard, boxes, buttons, mini wheels, etc.
- Tape
- Water bottle to test model systems
- Worksheet: Design a Model Irrigation System

Vocabulary:
- Acre
- Aqueduct
- Canal
- Crop
- Efficient Water Use
- Evaporation
- Extraction
- Ground water
- Irrigation
- Irrigation Diversion
- Natural Resources
- Precipitation
- Reservoir
- Surface Water

Background Agricultural Connections:
Water is a natural resource critical to agriculture. Even though most of the Earth is made up of water, only a small fraction is usable for man. Irrigation has been around for as long as humans have been cultivating plants. Farmers use water conservation practices such as irrigation with moisture sensors, conservation tillage, and riparian areas to help improve water efficiency. Agriculture accounts for about 85 percent of United States water consumption. Although agriculture accounts for a large portion of our water supply, large-scale farming could not provide food for the world's large populations without the irrigation of crop fields. All over the country farmers and ranchers worry about water as severe droughts, population growth, and declining ground and surface water reduce the amount of water available to grow food.

Interest Approach:
Adapted from a lesson of the Kansas Foundation for Agriculture in the Classroom.

1. Collect your materials: umbrella, towel, and spray bottle of water. Recommend this be executed outside. Alternatively, this activity could be done with a potted plant and spray bottle.
2. Have a student hold the opened umbrella with the top waist high so students can gather around and see the top. Place the towel on the ground directly where runoff would occur.
3. Have students hypothesize how water, if sprayed on the umbrella, would move.
4. Have another student spray the top, center of the umbrella and observe how the water moves down the ribs of the umbrella. Note if water falls to the towel below.
5. Pick up the towel and select a dry section. Have a student spray water on the bath towel and have students compare the water behavior between the umbrella and the towel.
6. Ask the students to imagine that the umbrella is a plant and the towel is the soil it's planted in. Discuss the following.
    a. What force of nature causes the water to flow on the sprayed umbrella, our imaginary plant? *Gravity.*
    b. Where does the plant require water for it to grow? *At the roots. In this case the root zone in the soil.*
    c. Did it make a difference in how much water would be available to this plant's roots if water was sprayed on the umbrella or on the towel? *Yes, pouring directly on the towel allows water placement at the plant roots.*
    d. Farmers must make decisions about how to get water to their large number of plants. We'll be exploring things they consider and the challenges they face when making these decisions.

Procedures:
Activity 1: Challenges in Irrigation - Evaporation experiment

1. Wet two identical pieces of cloth and wring the excess water out.
2. Place one of the pieces of cloth in an airtight plastic bag. Place the other piece of cloth in an open tray.
3. Position both items near a window with plenty of sunlight.
4. Make predictions regarding which item will dry up first: the cloth in the sealed bag, or the one exposed to the air.

5. Leave the items by the window overnight.
6. When you return to the experiment the next day, you'll see that the exposed cloth dried up, while the one sealed inside the bag remains moist. This is because the water molecules in the sealed cloth can't escape into the air like the ones in the exposed cloth.
7. Ask the student to share why evaporation might be a concern for farmers. Ask guiding questions to lead a discussion on loss of water for plants to utilize through evaporation means more water needs applied to meet the needs of the plants.

Activity 2: Challenges in Irrigation – Getting water to where it's needed

1. Gather materials: 1 large container filled with water to represent a water reservoir. At least 2 smaller disposable containers large enough to accept water that will represent farms (example: plastic 1-gallon ice cream bucket). Mark a horizontal line on the inside of your container at the same point on both containers to represent the minimum water level needed to support the crops. Enough small paper cups or similar objects for each of your students to transport water. The size of your cup and plastic container should be considered so that container doesn't spill over with just a few cups of water being transferred. Note: depending on class size, you may wish to break into smaller groups. This activity requires some space to navigate and is best done outdoors to accommodate for spills. If done indoors, modify the 1 leg restriction to reduce spills during hopping.
2. Place the large container of water in a central location and the smaller receptacles at an equal distance from the container of water on opposite sides of the room or space. Divide the class into two groups. Distribute 1 cup per student.
3. Introduce the challenge:
   Nevada had a lot of snow this past winter and the reservoir (introduce the container of water) is holding the snowpack runoff. Two new farmers are getting ready to plant their spring crops on opposite sides of the valley (introduce the two receptacles representing farms). Your job is to figure out how to get the water from the reservoir to the farms. The line at each farm represents the minimum amount of water the farmer needs to grow their crop this season. Team 1 will transfer water to farm 1 and team 2 will transfer water to farm 2. Each of you has been given 1 cup with which to transport the water, however each person on the team can only use one hand and one foot while transporting the water. Your team will have three minutes (adjust time as necessary) to plan a strategy before we begin.
   Useful tips: Likely a group will try to hop with the cups of water resulting in spillage. The best way of completing this task is for the group to form a chain and pass the cups up the line to the person closest to the reservoir. Then while balancing on 1 foot and only using 1 hand they can fill and pass the cups back down the line to the waiting receptacle.
4. Suggested questions during review
   a. How did you plan for the task? Did everyone share their ideas?
   b. What did you find most difficult? Why did you find it difficult and how could you prevent that from happening again?
   c. What worked well? Were you able to get enough water to the farm to grow the crop?

d. Did you get more water then was needed to grow the crop? If so, what do you think the farmer could do with that water (Answers may include, grow more of that crop or an additional crop, provide the water to livestock for drinking, put water in a holding pond for wildlife and birds to access).
e. How do you think water is moved from lakes, rivers, reservoirs, and aquifers to farms in real life? (Review surface water vs. ground water)
    i. Introduce aqueducts and canals
    ii. The ancient Romans constructed many aqueducts to route water to cities and other sites. These aqueducts are one of the greatest engineering feats of the ancient world. Many of the ancient aqueducts are still in use today. They served several functions including providing potable water and supplying water to baths and fountains. Water was then routed into the sewers, where they helped remove waste matter.
    iii. Introduce extraction of groundwater
    Source: USGS Water Science School
        1. The process of removing water from an aquifer.
        2. Wells are extremely important to all societies. In many places wells provide a reliable and ample supply of water for home uses, irrigation, and industries. Where surface water is scarce, such as in deserts, people couldn't survive and thrive without groundwater.
        3. Historically people dug a hole called a well by hand, shovel, and bucket. They would keep digging until they reached the water table and water filled the bottom of the hole.
        4. Modern wells are often drilled. Drill rigs are often mounted on big trucks. They use a rotary drill bit that chews away at the rock and soil. A pump is then placed in the hole to push the water to the surface.
        5. Withdrawing water from the well causes the water level to lower. If not enough water is recharged and refilling the aquifer, pulling too much water will cause your well to “go dry.” At that point you either have to do without water until the groundwater is replenished or you drill your hole deeper in hopes of pulling water from the lowered aquifer.

Activity 3: Irrigation Methods

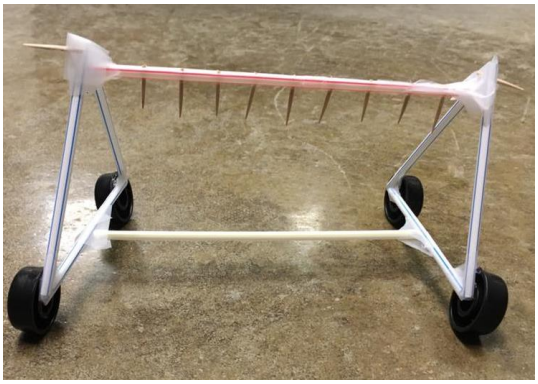
1. Irrigation is the method of getting water to plants. Ask the students
    a. Irrigation isn’t just used by farmers. Where else do you see water applied to plants? (school lawn, home lawn and yard, parks, sports fields with real grass).
    b. How is water applied to the plants in those situations? (sprinklers, flooding)
2. Once water reaches the farm either through extraction from underground aquifers or through canals or aqueducts from lakes, rivers, or reservoirs the farmer must use a tool to apply the water to the fields or individual plants, trees, or bushes.

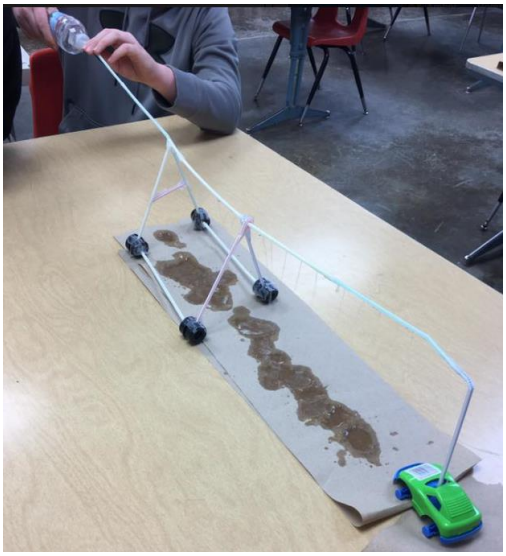
3. Divide the class into small groups and give each group a set of irrigation method cards. Instruct them to read each description and then match it to the picture representing that method of irrigation.
4. Distribute the worksheet: Irrigation Methods Venn Diagram and have students identify two irrigation methods and complete the worksheet.
5. Distribute the worksheets and watch the videos available at https://www.youtube.com/playlist?list=PLGdlCTs4dQTdFThAVQn_yZYcp_8ZMbTLf.
    a. Bently Ranch
        i. *Irrigation tools in production agriculture*
        ii. *What is a ranch manager?*
    b. Desert Farming Initiative
        i. *Irrigation tools in the greenhouse*
        ii. *Drip irrigation tools*
        iii. *Working at Desert Farming Initiative*
    c. Gilcrease Orchard
        i. *Irrigation tools*
        ii. *Working at Gilcrease Orchard*

Activity 4: Design a Model Irrigation System

1. Collect assorted materials: straws, buttons, toothpicks, plastic water bottles, cups, cardboard, tape, glue.
    a. Option 1: Give each small group the same materials.
    b. Option 2: Place available materials in a central location and allow small groups to design and then adapt design with materials still available.
2. Divide the class into groups of 2-3 students. Distribute worksheet: *Design a Model Irrigation System* to each group and have them complete the activity.
   Note: You can adapt this activity to include group presentations to the class at the stage of design or testing.
3. If time allows, students can continue the design editing and testing phases to reinforce engineering principals.

Example photos of student designs courtesy of Jordan Lea Richardson.





Enriching Activities

- Do as the Romans: Construct an Aqueduct! Hands-on activity by Center for Engineering Educational Outreach, Tufts University available at https://www.teachengineering.org/activities/view/construct_an_aqueduct
- Make a Water Well – Hands-on activity by Education.com available at https://www.education.com/activity/article/dig_a_well/
- Groundwater Foundation's Create your own center pivot – lesson and how-to video available at https://www.groundwater.org/kids/popularactivities.html.

Vocabulary

Acre: A unit of land area equal to 4,840 square yards. Roughly the equivalent size of a standard National Football League field not including the end zones.

Aqueduct: An artificial channel or pipeline build to transport water.

Canal: An artificial waterway constructed to convey water for irrigation.

Crop: A type of plant grown for food, fiber, or landscaping. Examples are apples, corn, lettuce, trees, cotton, and flowers.

Efficient Water Use: Tools and methods implemented by water users to maximize use of water available.

Evaporation: The process of turning from liquid into vapor.
Extraction: The process of removing water from an aquifer, typically by pumping it through wells drilled into the saturated layer of the aquifer.

Ground Water: Some precipitation infiltrates into the ground to become ground water. Ground water is the major contributor to many streams and rivers. Ground water is recharged by rainwater that falls onto soil and percolates down through the soil and rocks into the aquifer.

Irrigation: the application of water to land using man-made technology or methods. Irrigation can compensate for the naturally variable rate and volume of rain.

Irrigation diversion: A means of elevating and diverting water from the river into a canal that conveys water to fields, often miles away, for the purpose of irrigating cropland, hay land, and pasture.

Natural Resources: Natural resources are useful raw materials that we get from the Earth. They occur naturally, which means that humans cannot make natural resources. Includes land, minerals, forests, and water.
Precipitation: Rain, snow, sleet, or hail that falls to the ground.

Reservoir: A man made body of water to store water runoff from snowmelt or heavy rains.

Surface Water: Water on top of the ground (lakes, rivers, streams, oceans). Rain, and snow fall from the sky each year. About 1/3 of that water ends up in the rivers, lakes, and streams.

Water Table: The top of the water surface in the saturated part of an aquifer.

Well (water): A man-made method of drilling or digging a hole for withdrawing water from an underground aquifer.

Educational Standards Addressed

Nevada Academic Content Science Standards/Next Generation Science Standards

5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Nevada Academic Content Social Studies Standards

SS.4.24. Examine how and why Nevada's landscape has been impacted by humans.

SS.4.25. Analyze how technological changes have impacted the environment and economy of Nevada.

SS.5.3.6 Describe ways humans depend on natural resources

Nevada Academic Content English Language Arts Standards/Common Core

Key Ideas and Details:
CCSS.ELA-LITERACY.RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

CCSS.ELA-LITERACY.RI.4.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

CCSS.ELA-LITERACY.RI.4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

CCSS.ELA-LITERACY.RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

Craft and Structure:
CCSS.ELA-LITERACY.RI.3.4, 4.4, 5.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3, grade 4, grade 5, topic or subject area.

Integration of Knowledge and Ideas:
CCSS.ELA-LITERACY.RI.3.7 Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur).

CCSS.ELA-LITERACY.RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.

National Agricultural Literacy Outcomes

T1.3-4e Recognize the natural resources used in agricultural practices to produce food, feed, clothing, landscaping plants, and fuel. (Water)

T2.3-5e Understand the concept of stewardship and identify ways farmers/ranchers care for soil, water, plants, and animals.

T4.3-5.a Compare simple tools to complex modern machines used in agricultural systems to improve efficiency and reduce labor.

T4.3-5.b Describe how technology helps farmers/ranchers increase their outputs (crop and livestock yields) with fewer inputs (less water, fertilizer, and land) while using the same amount of space.

T4.3-5.d Provide examples of science being applied in farming for food, clothing, and shelter products.

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