Divide and Conquer: Changing Channel Shape

Author	Denise Dorn
Grade Level	6-7
Duration	1 class period

National Standards	AZ Standards	Arizona Social Science Standards
GEOGRAPHY **Element 1: The World in Spatial Terms** 1. How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information 3. How to analyze the spatial organization of people places, and environments on Earth's surface **Element 5: Environment and Society** 14. How human actions modify the physical environment 15. How physical systems affect human systems	**MATHEMATICS** **Geometry** 6.G.A.1. Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques to solve mathematical problems and problems in real-world context. 7.G.B.6. Solve mathematical problems and problems in a real-world context involving area of two-dimensional objects composed of triangles, quadrilaterals, and other polygons. Solve mathematical problems and problems in real-world context involving volume and surface area of three-dimensional objects composed of cubes and right prisms. **Standards for Mathematical Practice** 6.MP.7. and 7.MP.7 Look for and make use of structure.	**GEOGRAPHY** **The use of geographic representations and tools helps individuals understand their world.** 6.G1.1 Use and construct maps, graphs, and other representations to explain relationships between locations of places and regions. 7.G1.1 Use and construct maps and other geographic representations to explain the spatial patterns of cultural and environmental characteristics. Key tools and representations such as maps, globes, aerial and other photos, remotely sensed images, tables, graphs, and geospatial technology 7.G1.2 Analyze various geographic representations and use geographic tools to explain relationships between the location of places and their environments. **Examining human population and movement helps individuals understand past, present, and future conditions on Earth's surface.** 6.G3.1 Analyze how cultural and environmental characteristics affect the distribution and movement of people, goods, and ideas. 6.G3.2 Analyze the influence of location, use of natural resources, catastrophic environmental events, and technological developments on human settlement and migration. 7.G3.3 Evaluate the influences of long-term, human-induced environmental change on spatial patterns and how it may cause conflict and promote cooperation.

Overview

Access to water supplies is important to human survival. Humans often settle in places that have too little water. To deal with this deficit, humans redistribute natural water supplies. Generally, a river is dammed, creating a reservoir, and a canal or aqueduct carries the water to a new location. In other cases, the rivers are altered by narrowing them and by putting in artificial berms or levees. This lesson focuses on changing natural river channels.

Background Information for Teacher

In Arizona, the Salt River, and its tributary the Verde River, have 6 dams (Horseshoe, Bartlett Stewart Mountain, Mormon Flat, Horse Mesa and Roosevelt) that capture water from a 13,000 square-mile

watershed. In the past, the vast majority of water from this system was used for agriculture. However, with growth of the Phoenix metropolitan area, most of the water feeds urban and suburban uses.

There are benefits and disadvantages of water redistribution. The benefits include generation of hydroelectric power; flood control; recreation; extend water supply year-round; and the creation of new habitat for fish and birds. Some disadvantages include: the loss of land that is flooded by the reservoir; alteration of the ecology along the river below the dam; sedimentation behind the dam; changes in water condition below the dam; and loss of nutrients downstream from the dam.

Hydrologists, engineers and physical geographers use levees and canals to help control and distribute floodwaters. Many of these channels are built to contain anticipated flood events and protect development in the floodplain. The Salt River has many of these structures along its banks.

Prior to construction of the six dams, the Salt and Verde rivers used to flood every spring from rain and snowmelt. Now, they only flood during very wet years when too much water flows into the dams. However, when flooding does occur, the effects can be devastating.

In order to protect property, physical geographers and hydrologists work with civil engineers to design artificial channels. These artificial channels are designed to limit flooding to adjust the channel – keeping it away from property to the side. The goal is to create a balance between allowing building next to the river and protection from periodic flood events.

Channels have to be designed to move a lot of water during floods. The amount of water moved through a channel is called discharge. It is measured as a volume (e.g. cubic meters or cubic feet) per second. This is where the math in this lesson comes in. The discharge of a river is calculated by the very simple formulae $Q = AV$.

"*Q*" stands for discharge (in cubic feet or meters per second).

"A" is the cross-sectional area (feet or meters squared) at any given point.

"V" is the velocity (in feet or meter per second) of the water.

To determine if planned changes to a river course can carry the correct amount of water, physical geographers survey the area of a cross-section and compare it to a new design for that cross-section.

Natural river cross-sections do not generally have nice straight lines. To calculate cross-sections, we use a method called "divide & conquer". At different locations along the canal or river course a cross-section is selected, and its area is calculated. Any changes to the channel cross-section will alter the overall discharge.

Purpose

Water diversion projects often create changes to the local environment. In this lesson, students will explore the impact of water diversion projects by examining alternative river cross-section designs for such projects and selecting the best design.

Materials

- Background Information for Teacher
- Images for Student Notes
- Projection device
- Aerial Photograph of Big Creek Campground
- Divide and Conquer Note-Taking from Photo Show worksheets and Answer Key
- Divide and Conquer Practice and Answer Key
- Changing the Channel Assessment and Answer Key
- Calculators (optional)
- Videos of Flooding
  - https://www.youtube.com/watch?v=RluoQW0t2yQ
  - https://www.youtube.com/watch?v=4tCj-QzwfHI

Objectives

The student will be able to:

1. Describe the need, use, and impact of water diversion projects.
2. Use squares, rectangles, trapezoids, triangles, and circles to calculate the total cross-sectional area of different channel shapes.

Procedures

Students should have had experience in adding and multiply decimals and whole numbers.

1. Talk about flash floods and flood hazards in Arizona. If possible, show video clips. One video clip is from Mayer, Arizona and shows 2017 flooding associated with the monsoon. (1.23 min) https://www.youtube.com/watch?v=RluoQW0t2yQ The second video clip is of a 2018 flash flood (associated with Hurricane Rosa) in southern Arizona at Gila Bend. (3.15 min but only 1 min is needed) https://www.youtube.com/watch?v=4tCj-QzwfHI Both video clips introduce the idea that flooding can be hazardous, and floodwaters are

especially dangerous when they escape the river channel.
2. Now project the Images for Student Notes. The captions are the "script" for instruction. Students should take notes by answering a series of questions on the Divide & Conquer Note-Taking from Photo Show worksheets.
3. Tell students they are part of a team studying a plan for the channel of a river that runs next to a campground called Big Creek. Every three years heavy winter rains cause the river to flood the campground. The Forest Service needs to install a new bridge to the campground. The channel will be narrowed to accommodate the new bridge. At the same time, any change the channel shape must help prevent flooding of the campground.
4. Show students the aerial photo of the location.
5. Project and distribute the Divide and Conquer Practice worksheet. Tell the students that the Forest Service has provided the cross-section of the stream where it wants to make channel changes. Tell students there are 5-steps in the process for finding the cross-sectional area of a stream. They will complete this practice worksheet as a whole class.
6. Once they have the area of natural cross-section, they will then determine which plan for the new, narrower artificial channel will be best. Ask students if they are looking for a plan with a greater or smaller cross-sectional area. **Answer:** You need to have a greater cross-sectional area than the natural channel. A greater cross-sectional area will help keep the campground safe from flooding.
Note: Use of calculators will expedite the lesson. Extra paper will be needed for calculations if calculators are not provided.
7. Students should now work individually or in groups to complete the Changing the Channel assessment.

Assessment

Geography

The Divide and Conquer Note-Taking from Photo Show worksheets can be graded for completeness and accuracy. Mastery will be considered a score of 80% or higher.

Mathematics

The Changing the Channel Assessment can be graded for completeness and accuracy. Mastery will be considered a score of 80% or higher.

Extensions

https://www.srpnet.com/education/azwaterstory.aspx

This unit is designed for use in grades 4-6. Every effort has been made to integrate many subject areas (geography, history, science, math, and art) and to help students develop specific skills, such as critical thinking, organizing data, predicting, mapping and graphing.

Sources

Thanks to Rebecca Beard for use of the Camp Creek example materials and to the Tempe Historical Society and Arizona State University for the photographs.

Water Web Sites:
Central Arizona Project (www.cap-az.com)
Salt River Project (www.srpnet.com/)
Water Resources Research Center, University of Arizona (wrrc.arizona.edu)
U.S. Bureau of Reclamation (www.usbr.gov)
U.S. Fish and Wildlife Service (www.fws.gov)
U.S. Geological Survey (www.usgs.gov)