Divide and Conquer: Changing Channel Shape

Students learn about the pros and cons of water diversion projects, and use formulas for simple shapes to explore alternatives to natural channels.

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Grade Level: 6-7
Duration: 1 class period

National Geography Standards

<table>
<thead>
<tr>
<th>ELEMENT ONE: ENVIRONMENT AND SOCIETY</th>
</tr>
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<tbody>
<tr>
<td>14. How human actions modify the physical environment</td>
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Arizona Geography Standards

<table>
<thead>
<tr>
<th>Arizona Geography Strand 4</th>
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<tbody>
<tr>
<td>CONCEPT 5 Environment and Society</td>
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<tr>
<td>GRADE 6</td>
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<tr>
<td>PO 2 Describe the intended and unintended consequences of human modification on the environment.</td>
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<td>GRADE 7</td>
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<tr>
<td>PO 1 Identify the physical processes that influence the formation and location of resources.</td>
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<tr>
<td>PO 3 Describe how humans modify environments and adapt to the environment.</td>
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Other Arizona Standards

<table>
<thead>
<tr>
<th>Math Common Core Standards</th>
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<tbody>
<tr>
<td>Geometry</td>
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<tr>
<td>6.G.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 in the context of solving real-world and mathematical problems.</td>
</tr>
</tbody>
</table>

Standards for Mathematical Practice

| 6.MP.7. and 7.MP.7 Look for and make use of structure. |

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 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
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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.

Water diversion projects often create changes to the local environment. Students will explore the impact of water diversion projects by examining alternative river cross-section designs for such projects.

### Materials
- Teacher Information
- Photographs and Images to provide direct instruction to the student
- Student Activity Sheets
- Overheads of Student Activity Sheets
- Overhead of Answer Keys to Student Activity Sheets
- Pencil
- Calculators (optional)
- Answer Keys

### 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 that are linked to the lesson home page. One video clip is from China and shows flooding associated with a tidal surge where water moved back up a river channel and escaped the banks. The second video clip is of a flash flood in southern Arizona at Walnut Gulch, near Tombstone. Both video clips introduce the idea that flooding can be hazardous and floodwaters are especially dangerous when they escape the river channel.
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If possible, show sections of Hollywood movies. The section of the "Fellowship of the Ring" where the river floods or the section of the "Mummy" where a giant wall of water comes at the heroes are recommended.

2. Two files (same material) present a series of photos and captions. The captions are the "script" for instruction. Show this information by making overheads of the pdf (adobe acrobat reader file). Or, if possible, show the images on a computer screen by clicking on a link on the lesson home page. Students should take notes by answering a series of questions on the "Divide & Conquer Note Taking from Photo Show" sheets.

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. Show this information by making overheads of the pdf (adobe acrobat reader file), or show the images on a computer screen by clicking on a link on the lesson home page.

5. Make an overhead of the student page and show students the graph of the cross section survey where the Forest Service wants to make channel changes. Tell students that in order to make an effective plan, they will first need to find the cross-sectional area of the natural stream. Tell students there are 5-steps in the process for finding the cross-sectional area of a stream.

6. Once the students have the area of natural cross-section, they will 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 complete activity sheet.

Assessment
The student activity has assessments for geography (note taking) and math (activity sheet). Mastery will be considered 80% or higher on each student activity.

Extensions
Additional information for middle school students:

Water Web Sites:
Central Arizona Project (www.cap-az.com)
Salt River Project (www.srp.gov)
Water Resources Research Center, University of Arizona (www.ag.arizona.edu/AZWATER)
U.S. Bureau of Reclamation (www.usbr.gov)
U.S. Environmental Protection Agency (www.fws.gov)
U.S. Fish and Wildlife Service (www.fws.gov)

Sources

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