ROLL ON MIGHTY RIVER

EARTH matters
Studies For Our Global Future

introduction

The Colorado River runs like a lifeline through some of the most arid regions in the United States and Mexico. This mighty river carries between 6 and 24 million acre-feet of water per year, with an average of 15 million acre-feet. (An acre-foot is the amount of water that it would take to submerge an acre of land, which is about the size of a football field, to a depth of one foot.) It touches seven states before reaching Mexico, and its watershed covers one-twelfth of the continental U.S.

For several centuries, people have used water from the Colorado River to transform the landscape of the American West. Water supports not only crops, but also cities in the desert; the Colorado River provides **irrigation** for 4.5 million acres of agricultural land and provides water to 35-40 million people, including residents of Denver, Salt Lake City, Las Vegas, Phoenix, and Los Angeles. The river runs through seven national wildlife refuges and 11 National Park Service units (national parks and recreation areas) which receive about 20 million visitors each year. Both free-flowing and dammed areas provide a variety of opportunities for outdoor recreation. **Hydroelectric** power facilities along the river provide about 5.7 billion kilowatt hours of energy annually, which can provide all the electricity needs for over half a million homes.

But these benefits come at a price: seven Western states, Mexico, and several Native American reservations are allowed to use a portion of the river. The allocation for each U.S. state is based on the Colorado River Compact, created in 1922 during a particularly wet few years. As a result, the original apportionment was based on an overestimate of the normal flow and today, except in the wettest of years, the Colorado River dries up about 10-20 miles before reaching its historic mouth at the Gulf of California.

Climate change is already signaling a hot, dry future for the Colorado River Basin. Over 100 years after the Colorado River Compact, a new set of water use guidelines are scheduled to be negotiated by 2026 by all of the different stakeholders. This comes amid a historic **megadrought** (20+ years) in the southwestern U.S., producing the driest period in 1,200 years. Research points to human-caused climate change as a major cause of the drought's severity.

Vocabulary: hydroelectric, irrigation, megadrought

materials

For each group:

- Role-Playing Cards (provided)
- Suggested Research Sources
- Poster board (optional)

concept

Increasing demands on U.S. water supply and a diminishing amount of unpolluted water cause groups to compete for their "share" of the available supply.

objectives

Students will be able to:

- Research the position of a stakeholder competing for water from the Colorado River.
- Use argumentation to present their position as a stakeholder to a panel of peer judges.
- Design and/or evaluate a plan to equitably distribute water among several stakeholders.

subjects

Environmental Science (General and AP), AP Human Geography, Geography, Government, English Language Arts, Economics

skills

Role playing, researching, synthesizing research, debating, public speaking, conflict resolution, creating an action plan

method

Small groups of students take on the role of a stakeholder vying for water from the Colorado River and debate their position in a mock arbitration.

procedure

1. Read the Introduction above about the Colorado River to your students. If you are able, display the following satellite images of the Colorado River and Lake Powell (1999-2021) from the NASA Earth Observatory site and ask students to turn to a neighbor and discuss observations.

2. Divide the class into groups of 8-10 students and provide each group with one set of Role-Playing Cards. Six students will act as the concerned parties in the debate, each taking on the role described on one card. The remaining students in each group will form a panel of judges assigned to arbitrate conflicting demands on the Colorado River. (Groups may have 2-4 judges if numbers are uneven.)

3. Distribute the Suggested Research Resources list to each group. Allow the students time to research the position on their assigned Role-Playing Card. Encourage them to use charts, posters, or slides to summarize their positions. The judges will also need to spend time doing research to prepare for the trial. They should make a list of questions to ask the different sides during the arbitration, based on their own research.

4. Hold the arbitrations. To avoid distraction, separate the groups as much as possible, ideally in different rooms. During each arbitration, the parties present their cases, using visual aids and note cards when needed and then answer questions by their panel of judges.

5. After the presentations, each set of judges needs to decide on, and design, a plan of action. Each plan should then be presented in front of the class by one of the judges. The plan may include a specific course of action, such as giving more or less water to one of the parties. It could require that the parties conserve water. Or it could recommend technological solutions such as better irrigation equipment or fish elevators. The plan should clearly set priorities for water use in the area, justify these priorities, and indicate how conflicting demands might be met in the future.

alternate procedures

1. Create a panel of judges made up of 5-6 students. Divide the remaining students into six groups, each taking on the role of one of the stakeholders. As a group, they should conduct research on their role and then select one member to be the representative. During the arbitration, each representative can converse with members of their group as needed and after it is completed, the panel of judges should design a plan of action.

2. Divide the class into six groups, each taking on the role of one of the stakeholders. After conducting research on their role, each student should present their information to the other group members. Then, as a group, they must create an action plan for their specific stakeholder role. Once the plan is finalized, have each group present their plan to the class. After all groups present, hold a class vote on the best plan or compile sections from each to come up with a class consensus plan.

discussion questions

1. Do you think the action plan designed by your judges was fair? Why or why not**?**

   Answers will vary.

2. Were there any consistent themes in the presented action plans?

   Answers will vary.

3. What other resources are shared by various stakeholders and may face similar challenges?

   Most shared resources face similar issues. Various stakeholders must be considered when finding a management plan for fisheries, forests, energy use, arable land, etc. For example, forest management must consider the interests of loggers, developers, needs of local groups, environmentalists and so on.

4. If your group's action plan was put in place today, do you think it would still be effective five years from now? 20 years? 50 years? (Remember, we're still basing water usage from the Colorado River on an agreement from 1922!) Explain.

   Answers will vary. Students might mention that technologies being relied upon today may change, that population might increase/decrease in various areas and change the demand of various stakeholders, that perhaps other energy sources may increase/decrease and change the need for hydropower, etc. The current drought and climate change projections for the region will also be a consideration.

assessment

Evaluate students on the quality of their research, presentations, and proposals, as well as their engagement and contribution to the class activity.

follow-up activities

1. Students research the measures that California has put in place to deal with its recent historic drought. This provides a good example of how collectively, individual actions can make a big difference. Measures may include desalination plants, drip irrigation, water restrictions and conservation, xeriscape gardening, and wastewater recycling.

2. Have each student pick a shared water agreement that has happened or is happening in the world (e.g. the Ogallala Aquifer, the Jordan River, the Great Lakes agreement). Have students research the agreement and present their findings to the class. A useful resource for students to begin their research is the Global Water Partnership.

Background information in Introduction is from the *Layperson's Guide to the Colorado River*, prepared by the Water Education Foundation in Sacramento, CA, 2018. www.watereducation.org.

ROLL ON MIGHTY RIVER | role-playing cards

Sugar beet farmer in Colorado

You need water for irrigation to grow your sugar beets. Producing sugar in Colorado is an important farm industry and supports many jobs. Without water for irrigation, your farm would be worthless and you would have to move to the city to find work. About 70 percent of water withdrawn from the Colorado River goes to grow crops, but the majority of these crops are for growing livestock feed, like alfalfa and other grasses. Sugar beets, on the other hand, are directly consumed by people, supplying more than half of the sugar consumed in the U.S.

Planner for the Southern Nevada Water Authority (SNWA)

The Southern Nevada Water Authority (SNWA) regulates water for southern Nevada, including Las Vegas. You must provide water for a large tourist industry as well as a growing population, currently at about 2 million people. Drought, climate change, and population growth create unpredictable challenges with the long-term availability of water supplies. SNWA has made great strides in water conservation in the area, from providing financial incentives for homeowners to choose less water-intensive landscaping to moving away from the evaporative cooling towers that chill water to keep buildings air conditioned. Even so, climate change will make it harder to conserve enough water – the Las Vegas area is expected to warm by as much as 10°F by the end of the century.

Biologist for the Recovery Implementation Program for endangered native fish

This program was established in 1988 to help four species of endangered fish: the humpback chub, bonytail, Colorado pikeminnow, and razorback sucker. Your job's focus is on habitat restoration, fish hatcheries, flow regulation, and structural improvement. However this is a challenge due to dams blocking downstream flow of sediment and the introduction of non-native fish and vegetation, both proven detrimental to native fish populations. Your work has brought positive change – the populations of two of the endangered fish have stabilized and are gradually increasing. This is due, in large part, to the cooperation of other stakeholders to provide more water to the 15-mile stretch of the river that serves as an important habitat for the fish.

President of an electric utility company in Los Angeles

Most of the power you supply to your customers comes from the hydroelectric plants on the Colorado River. Los Angeles gets 15 percent of all the power generated off of the Hoover Dam, which sits on Lake Mead near Las Vegas. The exceptional drought has lowered the levels of the reservoirs in the West. In fact, the region's two largest reservoirs – Lake Powell and Lake Mead – are at their lowest levels since they were filled. These low water levels have slashed the electricity-generating capacity of major hydroelectric dams, forcing you to purchase power from more expensive and/or more environmentally damaging sources, and pass along the new costs to your customers. If the drought continues, you and other electric utilities who buy hydropower from Western reservoirs will be faced with even more difficult choices.

Representative of a Native American tribal government

You are a member of the Navajo Nation, one of 22 Indigenous tribes with claims to the Colorado River. Due to a lack of funds and infrastructure, the tribes aren't using all of their water rights. In fact, 40 percent of households in the Navajo Nation don't have running water in their homes. A new federal government policy may allow you to lease some of your unused water to bring in revenue to the reservation. Native Americans weren't considered U.S. Citizens when the 1922 Compact was signed and they are still having to advocate to make sure their water rights are protected.

Tour operator for a rafting company

Recreation, including rafting, is big business for the Colorado River Basin. More than 5 million adults annually visit the region for recreational excursions, supporting hundreds of thousands of jobs, and generating more than $10 billion a year in wages and earnings. Visitors come to the area to boat, ski, raft, canoe, fish, camp, and rent houseboats on Lake Mead and Lake Powell. The continued drought conditions could shorten the rafting season. Lower water levels can increase the risk of injuries while rafting.

ROLL ON MIGHTY RIVER | suggested research sources

These suggested sources are intended to help you start your research. Developments with Colorado River conditions and negotiations over water rights continue to change, so look for the most current sources and verify that they are reliable sources of information.

Overview of Colorado River issues:

- "What Happens When the Colorado River Runs Dry?" Science Friday. May 28, 2021. [Transcript and Audio file]: https://www.sciencefriday.com/segments/colorado-river-dry/
- "The Southwest's most important river is drying up." CNN. August 21, 2021. [Interactive site]: https://www.cnn.com/interactive/2021/08/us/colorado-river-water-shortage/
- "Water leaders in Arizona, Nevada, California agree to reduce reliance on Colorado River." Here and Now – WBUR Public Radio. December 17, 2021. [Audio file]: https://www.wbur.org/hereandnow/2021/12/17/colorado-river-agreement
- "Water in the Colorado River is Disappearing. Here's How the Government is Trying to Divide Up What's Left." 1A. WAMU Public Radio. September 21, 2021. [Audio file]: https://the1a.org/segments/colorado-river-drought-climate-change/
- Colorado River Compact of 1922: https://www.usbr.gov/lc/region/pao/pdfiles/crcompct.pdf

Background for Stakeholders:

Sugar beet farmer in Colorado:

- "Drought is forcing farmers in Colorado to make tough choices." NPR. November 6, 2021. [Transcript and Audio file]: https://www.npr.org/2021/11/06/1051527449/drought-farmers-southwest-colorado-climate-change
- "As the Colorado River shrinks, can new technology save water on farms? The answer is complicated." KUNC Public Radio. January 11, 2022. [Transcript and Audio file]: https://www.kunc.org/environment/2022-01-11/as-the-colorado-river-shrinks-can-new-technology-save-water-on-farms-the-answer-is-complicated

Planner for the Southern Nevada Water Authority (SNWA):

- "As Climate Change Turns Up the Heat in Las Vegas, Water Managers Try to Wring New Savings to Stretch Supply." Water Education Foundation. June 25, 2021. [Article]: https://www.watereducation.org/western-water/climate-change-turns-heat-las-vegas-water-managers-try-wring-new-savings-stretch

Biologist for the Recovery Implementation Program for endangered native fish:

- Colorado River District Endangered Fish Recovery Program. https://www.coloradoriverdistrict.org/supply-planning/endangered-fish-recovery-program/

President of an electric utility company in Los Angeles:

- "Drought Forces West to Turn to Fuels that Helped Cause It." Bloomberg Law. September 27, 2021. [Article]: https://news.bloomberglaw.com/environment-and-energy/drought-forces-west-to-turn-to-fossil-fuels-that-helped-cause-it

Representative of a Native American tribal government:

- Water & Tribes Initiative. Universal Access to Clean Water for Tribes in the Colorado River Basin. April 2021. [Report]: https://www.naturalresourcespolicy.org/docs/water-tribes/wti-full-report-4.21.pdf

- "Historically excluded from Colorado River policy, tribes want a say in how the dwindling resource is used. Access to clean water is a start." Colorado Public Radio. December 7, 2021. [Transcript and Audio file]: https://www.cpr.org/2021/12/07/tribes-historically-excluded-colorado-river-policy-use-want-say-clean-water-access/

Tour operator for a rafting company:

- National Integrated Drought Information System and National Oceanic and Atmospheric Agency. Recreation and Tourism Sector. https://www.drought.gov/sectors/recreation-and-tourism