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Sea Changes: How the Aral Sea is changing due to human activities

Teacher Guide

Introduction

The Aral Sea was once the fourth-largest lake in the world. It covered about 68,000 square kilometers (42,253 miles), an area slightly bigger than the U.S. state of West Virginia. It was home to a large fishing industry that fed thriving communities of people in the Central Asian countries of Kazakhstan and Uzbekistan, which are very ethnically diverse.

The Northern parts of the Aral Sea are in Kazakhstan. This area is the traditional home of ethnic Kazakh people. The southern parts in Uzbekistan are in a region that is the traditional home of the Karakalpak people. When the region was part of the Soviet Union, many other ethnic groups also moved to the area around the sea, including Russians, Tajiks and others. As the water supply has fallen, tensions between different groups have increased. This image, captured by a U.S. spy satellite in 1964, is one of the first images that we have of the sea taken from space.

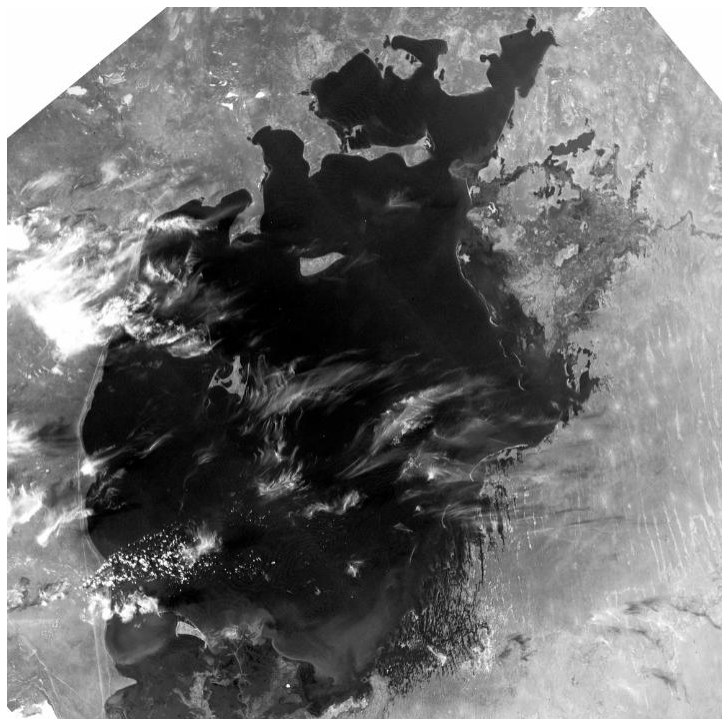


Image: Original Size of the Aral Sea

Today, the lake looks a bit different.

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Guiding Questions

- What causes the death of a lake?
- Can a lake's decline be reversed?

Location: Primary: Aral Sea, Kazakhstan, Uzbekistan

Grades: Grades 6-8, ages 11-14

Subjects: World Cultures and Geography

Possible instruction models:

- Front of class / demonstration
- 1:1 device
- Computer lab
- Homework / Flipped classroom

Time: This activity can be completed in one class period.

Skills: 2D/3D transition, elevation profile, satellite imagery,

Objectives:

- Students will be able to describe the Aral Sea crisis affecting Central Asia.
- Students will connect the causes and effects of human activity to environmental degradation, harmful health effects for the population, and regional economic decline.
- Students will compare and contrast lakes around the world experiencing similar decline and suggest actions that could prevent the loss of these water resources.
- Students will examine the health and history of locally significant bodies of water and record their findings.

Outline of Student Activity StoryMap

<https://storymaps.arcgis.com/stories/91400ace56be46d7b03d1adeb91fe4ce>

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First line of inquiry: The roots of the Aral Sea crisis

1. Students open a map showing one of the first known aerial images of the Aral Sea, taken by a United States spy satellite in 1964. A purple outline shows the rough extent of the Aral Sea as of 1964. Students then turn off the image from 1964 and compare this historic image to satellite imagery of the lake.

They answer the following questions:

- Does the current shape of the lake look like the image above? How would you say the lake has changed since 1964? (*The sea has shrunk significantly since 1964.*)
 - i. Make a qualitative observation, using words to describe the changes you see. (*The lake has shrunk since 1964. There is now a distinct North Aral Sea, and the South Aral Sea is a much smaller body of water.*)
- Using satellite imagery, can you tell what areas the Aral Sea used to cover? What signs might retreating water leave? (*Some of the now-exposed lakebed is a different color than the surrounding desert, maybe because of sediment or other particles left by the retreating water. In some places, you can also see some signs of erosion left by the water.*)

2. Students then use the map layers to explore other historical images of the lake up to the summer of 2025 to monitor the Aral Sea's retreat over time.

Then, students use the Measure tool to make quantitative observations about the sea.

- Students should fill out the following table with their measurements (answers will vary slightly depending on where students start and end their measurements)

East-West distance (1960s): <i>roughly 180 miles (291 kilometers)</i>	North-South distance (1960s): <i>roughly 240 miles (382 kilometers)</i>
East-West distance (2025): <i>North Aral Sea = 60 miles (97 kilometers), South Aral Sea = 11 miles (18 kilometers)</i>	North-South distance (2025): <i>North Aral Sea = 40 miles (72 kilometers), South Aral Sea = 98 miles (158 kilometers)</i>
Difference: <i>North Aral = 120 miles (194 km), South Aral = 169 miles (273 km)</i>	Difference: <i>North Aral = 200 miles (310 km), South Aral = 142 miles (224 km)</i>

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Second line of inquiry: What causes the decline/death of a lake?

1. Students learn that the Aral Sea is fed by two rivers, the Amu Darya and Syr Darya. They use bookmarks to navigate to the mouth of the Amu Darya.
 - Does water from this river appear to reach the Aral Sea? *(Based on the imagery alone, it doesn't look like any of the river channels reach the South Aral Sea anymore. From the Environment Surface Water and Label layer, students can see where channels from the river delta used to reach the sea.)*
 - What kind of ecosystem would you describe this region as having? How might this impact the amount of water in the river? *(This region has an arid, desert ecosystem. There is a lot of agriculture in the region, fed by the Amu Darya.)*
2. Next, students repeat this exploration at the mouth of the Syr Darya.
 - What types of land use do you notice in these areas? *(Agriculture.)* How does this compare to the surrounding region? *(Desert.)*
3. Challenge: Have students see if they can trace the path of the Amu and Syr Darya back to their source. How far can they follow the rivers? What kinds of land and water usage can they see along the rivers' paths?
4. The Aral Sea is one of the most advanced desertification crises in the world, but it's not the only one. Break students into small groups or assign them to locate other water bodies that are in crisis:
 - ♣ [Great Salt Lake, Utah, United States](#)
 - ♣ [Lake Chad, Chad](#)
 - ♣ [Lake Poyang, China](#)
 - ♣ [Lake Poopó, Bolivia](#)
 - ♣ [Lake Cuitzeo, Mexico](#)

Prompt students to use what they've learned to find possible similarities and differences between the Aral Sea and their assigned water body. You can also discuss differences in physical geography with students, such as the depth and surface area of the lakes, and how this might impact their change over time.

- **Question 1:** How does the 2014 imagery compare to the more recent basemap imagery? Use qualitative (words) and quantitative (measurements) statements to describe the differences. *(Answers vary, but should describe specifics about the lake shrinking.)*

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- **Question 2:** Based on what you learned from the Aral Sea, what might account for the differences you see between 2014 and the current maps? Look for land use, land cover, and cities or towns nearby to make and explain your hypothesis. *(Answers will vary. In some cases, particular land use types, such as large urban settlements or agricultural areas will be obvious. In other cases, none of these causes may be visible on the map.)*
- **Question 3:** Based on your hypothesis about this lake, what do you think are some steps local leaders and residents could take to help it recover? Why do you think these steps might help? *(Answers will vary.)*

Third line of inquiry: The Resurrection of a Lake

1. The North Aral Sea has been a lot more stable than the ever-shrinking South Aral Sea. This is because the Kazakhstan government has taken action to prevent further destruction of the sea. One of these actions is the construction of the Kok-Aral Dam. Students locate the dam on the map and answer the following questions:
 - Do you think the dam has been successful in maintaining water levels in the North Aral Sea? What might be done to help preserve water levels in the South Aral Sea? *(From the satellite imagery, it looks like the dam has done a good job at stabilizing water levels in the North Aral Sea. Consider that this is likely paired with other actions, such as regulating water levels in the Syr Darya to make sure that enough water flows into the North Aral Sea.)*
 - Consider that no one solution is perfect. What might be other consequences of installing a dam? *(Dams can change ecosystems, changing characteristics of water bodies such as salinity and temperature. They alter the natural flow of water. While a dam seems like a good idea in this case, this may not be true in all cases.)*
2. Students finish the activity by finding a water body local to their area and using what they've learned to see if this water body has changed over time. Have students answer the following questions alone, with a group, or as a class, drawing on local knowledge of the area. If these efforts or changes have occurred during the lifetime of parents/grandparents, consider having students do first person interviews.
3. What do you know about this water body? List what you know, then consider what gaps there might be in your knowledge. Write two questions you might ask to research this topic.

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Your knowledge:

Questions you might ask to learn more:

- How is the health of this body of water? Consider whether it's shrinking, polluted, or has any non-native or invasive species affecting it.

Your knowledge:

Questions you might ask to learn more:

- How might local land use affect this water body?

Your knowledge:

Questions you might ask to learn more:

- Are there active or historic conservation efforts targeting this body of water? Do any of your older family members, neighbors, or community members have memories of this body of water that differ from your lived experience?

Your knowledge:

Questions you might ask to learn more:

- What kind of impact do you think this body of water has on your community? What actions could you, your community, and your local government take to ensure its health for generations?

Your knowledge:

Questions you might ask to learn more:

Vocabulary

Desertification - a process by which semiarid land is converted to desert by human factors, natural factors, or some combination of the two.

River channel - the deepest part of a shallow body of water, often a passageway for ships

River delta - the flat, low-lying plain that sometimes forms at the mouth of a river from deposits of sediments.

[Qualitative data](#) - descriptive information that does not use numbers.

[Quantitative data](#) - measured information using numbers.

Additional supporting resources:

National Geographic: These Waters Carry the Ghosts of Ancient Empires (article)

- <https://education.nationalgeographic.org/resource/these-waters-carry-the-ghosts/>

National Geographic: Iran's Tarnished Gem (article)

- <https://education.nationalgeographic.org/resource/irans-tarnished-gem/>

National Geographic: What a shrinking sea might teach us on life after environmental disaster (article)

- <https://www.nationalgeographic.com/environment/article/aral-sea-climate-change-desert-laboratory>

Connections to National Standards, Principles, & Practices

C3 Framework- Geography

- **D2.Geo.4.6-8:** Explain how cultural patterns and economic decisions influence environments and the daily lives of people.
- **D2.Geo.5.6-8:** Analyze combinations of cultural and environmental characteristics that make places similar or different.
- **D2.Geo.7.6-8:** Explain how changes in technology influence spatial connections and diffusion.
- **D2.Geo.8.6-8:** Analyze how relationships between humans and environments extend or contract spatial patterns of settlement and movement.
- **D2.Geo.9.6-8:** Evaluate the influence of long-term human-induced environmental change on spatial patterns of conflict and cooperation.
- **D2.Geo.10.6-8:** Analyze ways in which cultural and environmental characteristics vary among regions.