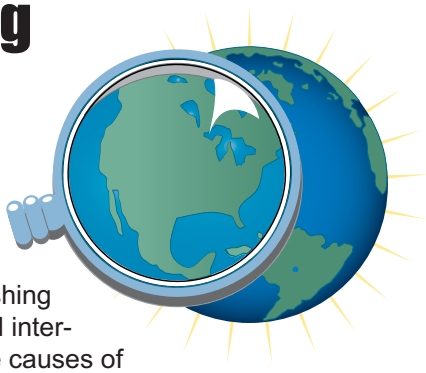
What is happening to the Aral Sea?



Investigation Overview

In Investigation 2, students work as teams of NASA geographers using satellite images to measure the diminishing size of the Aral Sea. They analyze and interpret graphic and tabular data about the causes of the shrinking sea and its effects on habitat, resources, and people in order to report their recommendations for improving this resource for future use.

Time required: Five to eight 45-minute sessions (as follows):
- Introduction and Part 1: Two or three sessions
- Part 2: One session
- Parts 3 and 4: One or two sessions
- Conclusion and debriefing: One or two sessions

Materials

Briefing and Log, one copy for each student
Transparency of Figure 5 in Briefing
Graph paper
Computer with CD-ROM drive. The Mission Geography CD-ROM contains color graphics needed for this activity.
Access to the Internet, which offers opportunities for extending this activity

Content Preview

The Aral Sea, which lies in an interior basin, has shrunk because the rivers that flow into it have been diverted for irrigation. This has caused both positive and negative physical and human consequences.

Classroom Procedures

Beginning the Investigation

1. Introduce this as a puzzle. Show a transparency or slide of abandoned Aral Sea fishing boats (**Figure 5** in **Briefing**, *without the caption*), and ask students to solve the puzzle. Ask students what they think happened here. Keep the discussion open ended and entertain numerous ideas, but don't provide answers. Simply tell students that they will be investigating this puzzle, which is about a huge lake—about the size of Lake Huron—in Central Asia, called the Aral Sea.

Developing the Investigation

2. Hand out copies of the **Briefing** and **Log** to each student or to small groups of students. Students can work individually, but small groups of two to four are recommended.

Geography Standards

Standard 4: Places and Regions

The physical and human characteristics of places
- Describe and interpret physical processes that shape places.
- Explain how social, cultural, and economic processes shape the features of places.
- Evaluate how humans interact with physical environments to form places.

Standard 7: Physical Systems

The physical processes that shape the patterns of Earth's surface
- Explain Earth's physical processes, patterns, and cycles using concepts of physical geography.

Standard 14: Environment and Society

How human actions modify the physical environment
- Evaluate the ways in which technology has expanded the human capacity to modify the physical environment.
- Develop possible solutions to scenarios of environmental change induced by human modification of the physical environment.

Standard 15: Environment and Society

How physical systems affect human systems
- Analyze examples of changes in the physical environment that have reduced the capacity of the environment to support human activity.

Geography Skills

Skill Set 3: Organizing Geographic Information
- Select and design appropriate forms of graphs, diagrams, tables, and charts to organize geographic information.

Skill Set 4: Analyzing Geographic Information
- Make inferences and draw conclusions from maps and other geographic representations.

3. Leaf through the materials with students and point out the underlined questions, which are to be answered on the **Log** at the end of the materials. Give students a schedule for completing the several questions.

4. Have students read the first two sections: **Background** and **Objectives**. Take questions and ask questions to be sure students understand the reading. For example, draw out examples in support of the ideas in the Background. Have students explain the difference between, and give examples of, fresh and salt water lakes. Begin a discussion of lakes as resources. Are lakes resources? How do people use lakes? What can happen to lakes that affect their use as resources? How can people change lakes for better and for worse?

5. Form teams of two to four students to be NASA geographers studying recent changes in the Aral Sea. Emphasize that they will be required to make recommendations to improve the Aral Sea as a resource, so it is important that they carefully work through all the material. Have the teams begin with **Part 1: How can you measure changes in the size of the Aral Sea?** and help them as needed as they work through the procedures, putting their answers in the Log.

6. Students may need some guidance in using the grid (**Figure 4**) on the satellite images to measure the size of the sea surface. Students can lay the images over the grid on a window or light table. Alternatively, you may wish to provide transparencies of the grid. In any case, remind students that this method of measurement (a "count GIS") will only give an estimate.

7. As you move from team to team answering questions and monitoring progress, you may find that some students will need assistance computing the percentage change to the Aral Sea. Since the estimates of size may vary considerably, the percentage changes will also vary.

8. **Part 2: Why has the Aral Sea been shrinking?** is the second major question in the investigation. Students are asked to *hypothesize* about the causes and to list their hypotheses on the Log at Questions 8 and 9. (The word hypothesis is used here to simply mean "explanation.") You may need to discuss the difference between *physical* processes (natural) and *human* processes (caused by humans). Encourage teams to discuss the meaning and plausibility of their hypotheses. Also, have them suggest the information they would need in order to test their hypotheses. These questions have no single, correct answers but should encourage critical thinking along new lines of thought. Remind them to put their answers to the questions on the **Log**. Emphasize to students that they should test their hypotheses with data in this part and in **Part 3: How has the region's landscape changed?** The **Background** below will give you the most commonly held scientific interpretation of what happened.

9. Students may need help interpreting Tables 1 and 2. Be sure they can explain the terms: *surface elevation, precipitation, evaporation, annual river inflow, and volume*. Students can convert some of the figures in the tables to English system equivalents if you want them to practice that skill. If you wish, you can also have them practice the skill of computing percentage changes over time for one or more of the categories in Tables 1 and 2. In any case, they need to study Table 1 to answer Question 10.

10. You may wish to hold a general discussion to help students answer Question 11, "What physical processes might explain the changes in precipitation and evaporation shown in Table 1?" To direct this discussion, see the answer to Question 11 in the Log Key. Students should understand the relationships among the data provided in the tables and figures. For example, in Table 1, evaporation from the sea decreased because the size of the sea was decreasing—there was less surface area from which to evaporate. In Table 2, as population increases, both irrigated area and water withdrawals increase; and the increasing salinity shown in Table 5 corresponds to the decreasing volume shown in Table 1.

11. You may wish to provide graph paper for the exercise for Question 12. A basic framework is given in the answers to the Log. You may wish to give that framework to students so they can simply plot the data for the three variables (year, population, irrigated area). Or, you may wish to challenge students to design their own graphs. In any case, they should add (and justify) their projections for 2000 and 2010.

12. **Part 3: How has the region's landscape changed?** and **Part 4: What are the human consequences of the shrinking Aral Sea?** provide information about physical and human consequences.

Concluding the Investigation

13. Teams should write their final reports to NASA, using the guidelines given in Question 15.

14. You may wish to debrief the investigation by discussing the Log, especially emphasizing the recommendations students have made in their final reports. Alternatively, use the Objectives listed at the beginning of the **Briefing** to organize the debriefing. You could also draw the investigation to an end by asking students to weigh the economic benefits against the consequences of this regional development scheme.

Background

The Amu Darya and Syr Darya Rivers empty into the Aral Sea, which lies in an interior basin. The development by the Soviet Union of irrigation projects in the region, especially to grow cotton beginning in the 1950s, captured the river waters so that little fresh water reached the Aral Sea. Withdrawal of water from the Amu Darya and Syr Darya, primarily for irrigation, is the most important factor reducing water flows into the Aral Sea. This caused the Aral Sea to shrink in size.

The shrinking Aral Sea has had both positive and negative physical and human consequences. Agricultural production and population in the region increased dramatically, thus improving the economy of the region, which was clearly the main goal of the Soviet government planners. On the other hand, contaminated soil and water resulted from the use of chemical pesticides, herbicides, and fertilizers. And soils became saltier (salinization) and less suitable for agriculture. In addition, as the waters of the sea retreated, salty soil remained on the exposed lake bed. Dust storms blow away up to 75,000 tons of this soil annually, dispersing its salt particles and chemical residues into the air. This air pollution has caused widespread nutritional and respiratory ailments. This is not necessarily an example of unintended consequences. Perhaps some of these negative ecological consequences were unintended, but there is no clear evidence of this. It is just as likely that the goal of economic development in the short run took precedence over the long-term goal of environmental stability and protection.

Evaluation

Log

1. What is the latitude and longitude at the center of the Aral Sea?
   45 degrees North and 60 degrees East

2. What countries surround the Aral Sea?
   Kazakhstan and Uzbekistan

3. What is the surface area in square kilometers of the Aral Sea in 1964?
   51,609.6 square kilometers, but estimates may vary from about 48,500 to 53,700 square kilometers.

4. What was the surface area in square kilometers of the Aral Sea in 1997?
   26,542 square kilometers, but estimates may vary from about 23,000 to 28,000 square kilometers.

5. What was the percentage change in the surface area of the Aral Sea from 1964 to 1997?
   The Aral Sea decreased in size about 50 percent, but calculations may vary from about 40 to 60 percent.

6. How did the satellite imagery help you to draw conclusions about changes in the Aral Sea?
   Satellite imagery is helpful in determining changes to the Aral Sea because you can examine the entire water body in a single image and compare it with images taken at earlier times.

7. Name the two major rivers that flow into the Aral Sea.
   Amu Darya and Syr Darya

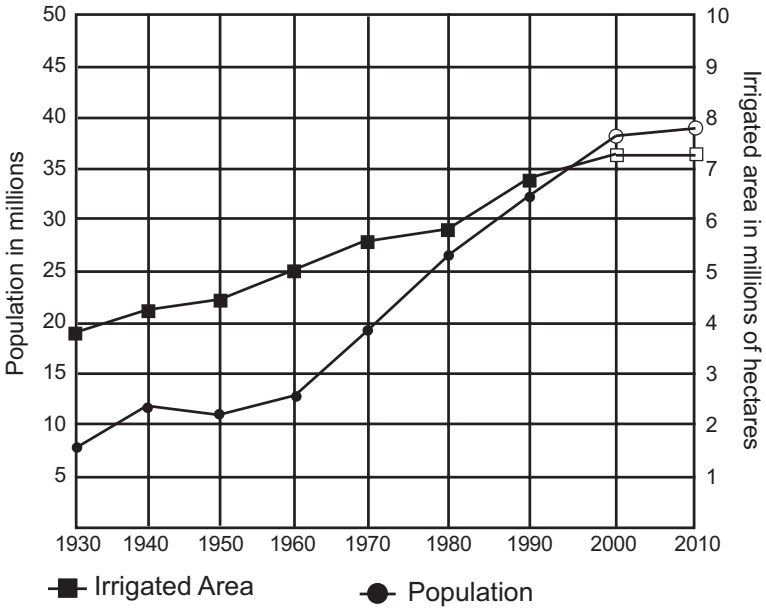
8. List your hypotheses about physical processes that have caused the Aral Sea to shrink.
   Rising regional temperatures resulted in higher rates of evaporation.
   Regional drought reduced snowfall in the mountains, the source areas of the major rivers that flow into the Aral.

9. List your hypotheses about human processes that have caused the Aral Sea to shrink.
   Human use of the water source for large-scale irrigation agriculture reduced the inflow to the Aral.
   In-migration caused a rapid rate of increase of the human population in the region, which increased the demand for domestic water.

10. Fill in the blanks below (with the words *increasing* or *decreasing*) to indicate what has been happening to the Aral Sea.
    The data in Table 1 show that the Aral Sea has been <u>decreasing</u> in surface elevation, precipitation has been <u>decreasing</u>, evaporation has been <u>decreasing</u>, annual river flow has been <u>decreasing</u>, and the volume of the sea has been <u>decreasing</u>.

11. What physical processes might explain the changes in precipitation and evaporation shown in Table 1?
As the inflow is reduced, the volume of water in the sea is reduced, which results in a reduction of the surface area. A smaller surface area means less evaporation from the sea surface. Less evaporation puts less water vapor into the air and thus less that is available for precipitation.

12. Graph the data in Table 2 to illustrate the relationship between irrigation in the Aral Sea region and human population growth. Include projections for 2000 and 2010 on your graph. Write a description of the relationship(s) below your graph.
Over time, irrigated area increased as population increased, but both are likely to slow because of environmental problems and increasingly scarce agricultural resources.



13. How has the shrinking of the Aral Sea affected the human populations in the region?
- *The traditional fishing industry, which supported thousands of people in the region, was destroyed, thus destroying the livelihoods of these people.*
- *Large areas, formerly under water, became exposed to wind erosion; salt-dust storms caused air pollution, which led to respiratory diseases.*

14. What types of human activity can you detect from the Space Shuttle image in Figure 7?
Numerous rectangular shapes are agricultural fields. Very large areas are covered with these shapes, which indicate a large amount of agriculture.

15. Final team report. Briefly describe what has happened to the Aral Sea. Indicate how human consequences have been related to the decline in the size of the sea. You should also make predictions about what will happen in the future. Finally, make recommendations for government planners on how to reduce the environmental problems of the region and how to manage the region's water resource and stabilize the Aral Sea.

The Aral Sea has significantly decreased in size over the last 40 years as a result of human demand for water; in particular, water has been diverted from the sea to irrigate cotton and rice. The Aral Sea is landlocked and has no outlet. The development of irrigation projects has reduced the amount of fresh water reaching the Aral Sea from the Amu Darya and the Syr Darya Rivers, drastically increasing the salinity of the sea. Residues of chemical pesticides, herbicides, and fertilizers have contributed to water pollution; air pollution from salt dust storms has contributed to nutritional and respiratory ailments.

Students should be credited for all reasonably practical recommendations. As a guide, the following four steps were recommended by a conference of 200 scientists in 1990:
- *Strictly limit water use by countries in the region and introduce water-saving technology in all areas of the economy.*
- *Prohibit expansion of irrigated land to free river flow for preserving the Aral Sea.*
- *Limit rice and cotton agriculture and remove unproductive land from irrigation. Develop instead orchards, vineyards, and other crops that use less water.*
- *Remove systems that drain polluted agricultural runoff from irrigated land to the Aral Sea.*

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What is happening to the Aral Sea?

Background
Lakes become salty when they form in interior basins in arid areas. Water contains salts, and when water evaporates, the salts remain to accumulate. Without a continuing inflow of fresh water, these lakes become smaller and saltier. The Great Salt Lake in Utah and the Salton Sea and Mono Lake in California are examples of lakes that have no outlets and have become salty. These salt water lakes are more prone to pollution problems than are fresh water lakes. This is especially true when the amount of water flowing into them is severely reduced. The Aral Sea, in arid central Asia, is the world's leading example of a shrinking salt lake that is suffering from pollution problems. In 1973, it was the fourth largest lake in the world, but by the 1990s it was only the sixth largest lake. In this investigation, you will be a geographer on a NASA team finding out what is happening to the Aral Sea, and why the changes threaten entire ways of life for millions of people.

Objectives
In this investigation you will
- locate the Aral Sea and describe its physical characteristics,
- use satellite imagery to identify and measure recent changes in the Aral Sea,
- explain how human activities have changed the physical characteristics of the Aral Sea and its surroundings,
- discuss the consequences of human actions on the Aral Sea and how the resulting changes are affecting human populations, and
- recommend actions to reduce further damage to the Aral Sea and the human populations that use its resources.

Part 1: How can you measure changes in the size of the Aral Sea?
Imagine that you are a member of a team of geographers working for NASA to survey Earth's water resources. Your team is investigating changes to the Aral Sea over the last 40 years in order to assess the current and future condition of the Aral Sea as a resource. First, locate the Aral Sea in Figure 1, which is a map of the region made by the U.S. Geological Survey. Estimate the latitude and longitude of the sea and note the countries that surround it.

<u>Answer questions 1 and 2 on the Log following the Briefing.</u>

Your team will use a *time-series* of satellite images of the Aral Sea taken from 1964 to 1997 (Figures 2 and 3) to estimate the change in the size of the Aral Sea over time. The squares labeled 38.4 kilometers on a side in the lower left-hand corner of the images represent 1474.56 square kilometers (38.4 X 38.4 = 1474.56).

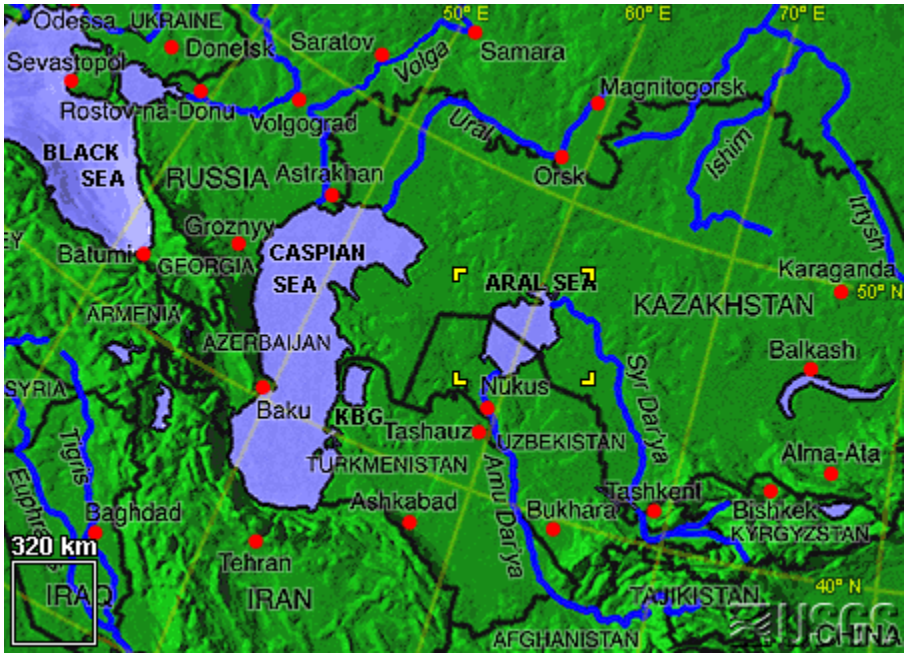

Figure 1: Map of Central Asia
Source: http://edcwww.cr.usgs.gov/earthshots/slow/Aral/Aral

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To estimate how the Aral Sea has changed in size, you will use a procedure that is part of a geographic information system (GIS). GIS is a way to store, analyze, and display many kinds of data. Most GIS procedures start by dividing an area into smaller units, much like the squares in the bottom of each image of the Aral Sea (Figures 2 and 3). A count (or inventory) GIS procedure is designed to answer questions about an entire area, such as "How large is the Aral Sea?"

Using the GIS count grid provided in Figure 4 (or a transparency), lay it on or under Figure 2 (the 1964 satellite image). Line up the bottom left square from the GIS count grid with the square on the image and then count the number of times the points in each square lie on the sea surface. If part of the point lies on the Aral Sea, count it for your estimate. Then estimate the surface area by multiplying the total number of points by the grid measure (1474.56 square kilometers).
Surface area in square kilometers = number of points in grid squares X 1474.56 square kilometers

Answer question 3 on the Log.

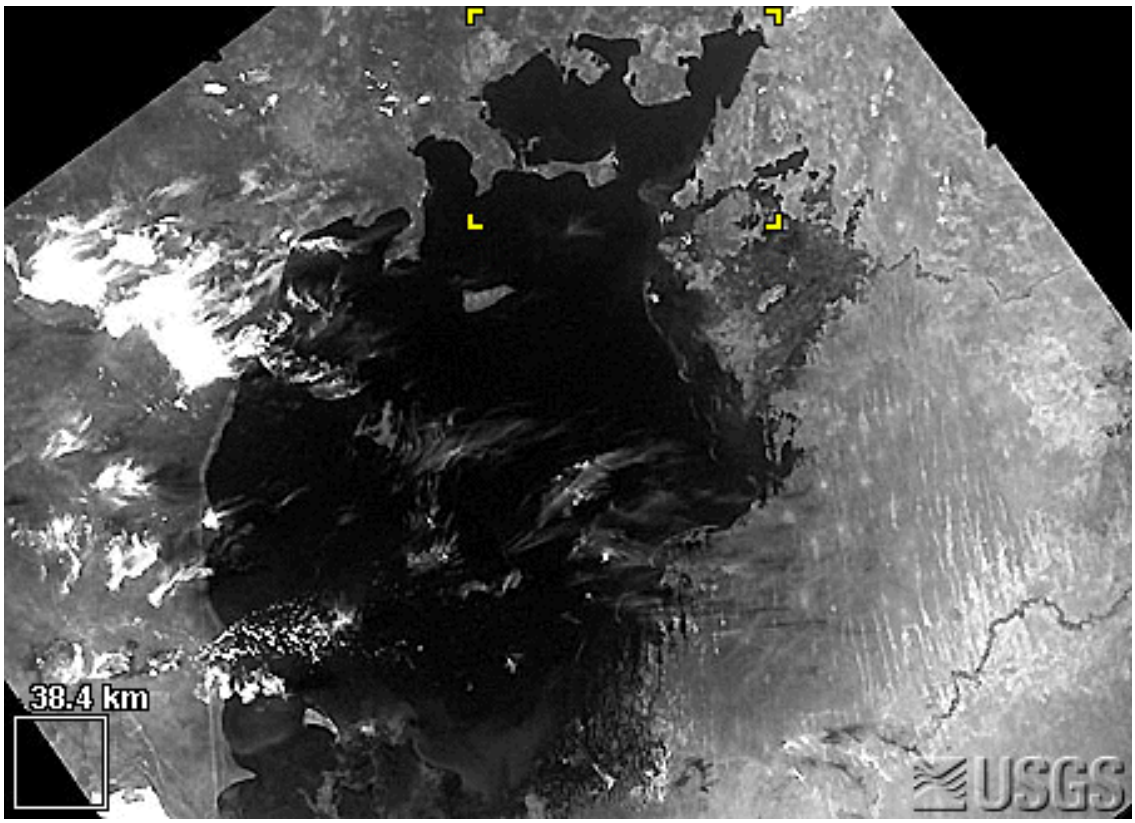

Figure 2: The Aral Sea on August 21, 1964; Argon satellite photo

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Now that you have determined the size of the Aral Sea for 1964, measure the size of the Aral Sea in 1997 (Figure 3).

Answer question 4 on the Log.

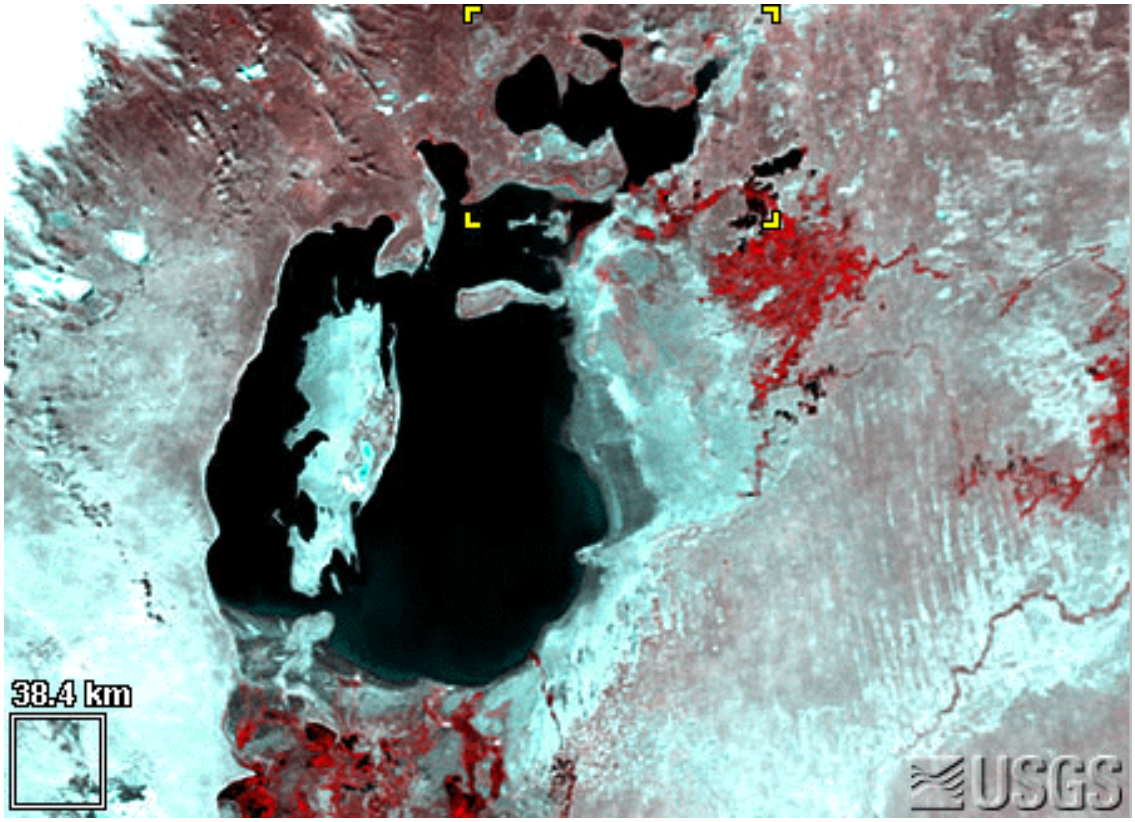

Figure 3: The Aral Sea on July 11, 1997; NOAA 14 AVHRR bands 2 1 1

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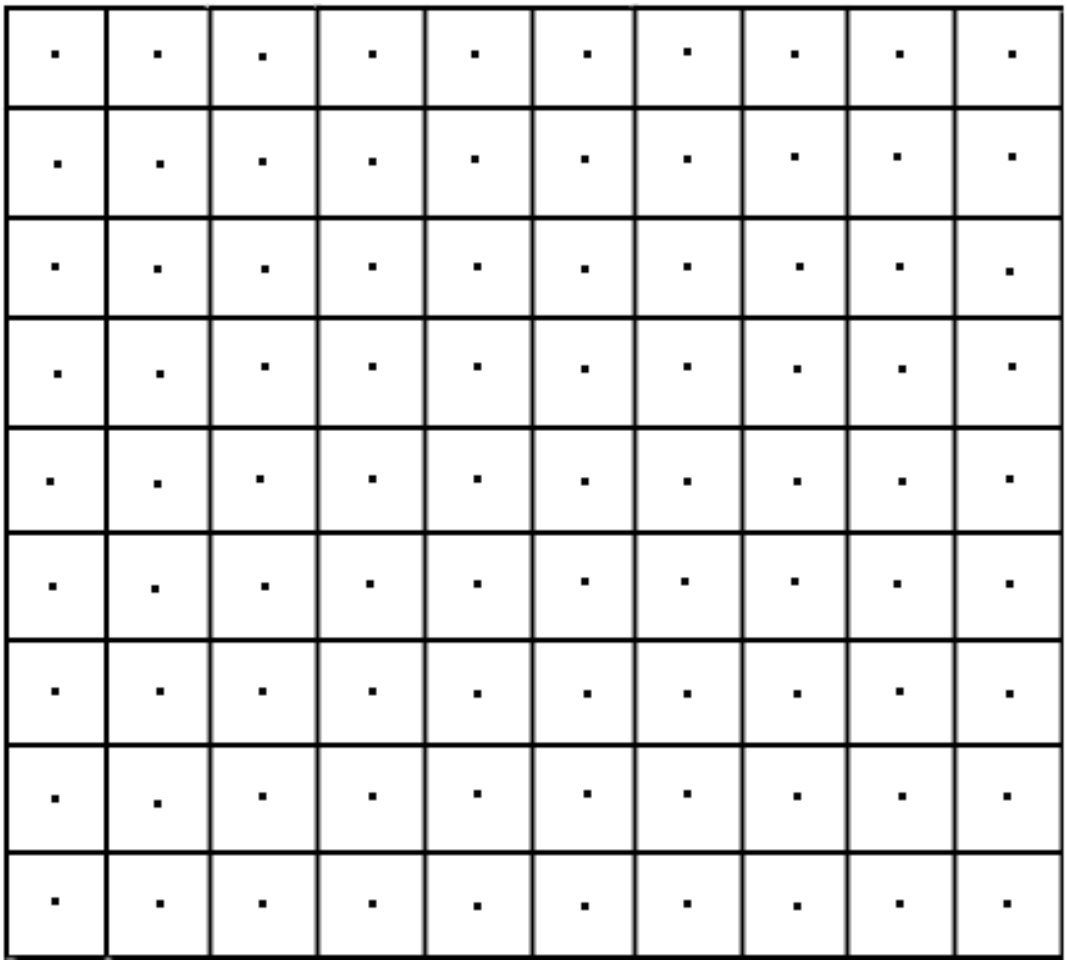

Figure 4: GIS count grid for Aral Sea

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Next, compute the *percentage change* in the size of the surface area of the Aral Sea from 1964 to 1997. To do this, use the following mathematical procedure:

$$\text{Percentage change} = \frac{\text{square km in 1964 - square km in 1997}}{\text{square km in 1964}} \times 100$$

For example, if your 1964 estimate is 20,000 square miles and your 1997 estimate is 10,000 square miles, subtract 10,000 from 20,000 and divide by 20,000 to get 0.5. Multiply that by 100 to get the percentage, or 50 percent.

Answer question 5 on the Log.

Now that you have your estimates for the change in the size of Aral Sea over time, consider how satellite imagery helped you to draw conclusions about changes in the Aral Sea. What does satellite imagery allow you as a geographer working for NASA to accomplish?

Answer question 6 on the Log.

Part 2: Why has the Aral Sea been shrinking?

Government agencies are interested in reducing the loss of the Aral Sea and need to know the major causes of its decline. Use Table 1 to determine the sources of the Aral Sea's water supply.

Answer question 7 on the Log.

Consider the possible causes of the shrinking of the Aral Sea. A key step in scientific research is to *hypothesize*—to suggest explanations for the things you observe. Your team should make two lists of hypotheses to explain the shrinking of the Aral Sea. On the first list, identify causes that are physical processes. For example, the sea might be shrinking because the rate of evaporation has increased (but what would cause this?). Label the second list human processes. For example, in-migration has caused a rapid rate of population increase in the region, which has made increasing demands on the water supply that flows into the sea.

Answer questions 8 and 9 on the Log.

Your team should now begin to test its hypotheses about the causes of the Aral Sea's decline. Use the information in Table 1 and Table 2 to help you do this.

Answer questions 10, 11, and 12 on the Log.

Table 1: Aral Sea surface elevation, precipitation, evaporation, river inflow, and volume, 1950-1990.

	Surface elevation above sea level (meters)	Precipitation (cubic kilometers)	Evaporation (cubic kilometers)	Annual river inflow (cubic kilometers)	Volume (cubic kilometers)
1950	52	9	66	63	1,083
1960	53	9	66	56	951
1970	51	8	65	43	628
1980	45	6	55	17	329
1990	38	5	39	4	282

Sources: P. Micklin and W. Williams, *The Aral Sea Basin*, NATO, 1996

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Table 2: Population, irrigated area, and water use, Aral Sea region, 1930-1990.

	Population (millions of people)	Irrigated area (millions of hectares)	Water withdrawals for irrigation (cubic kilometers)
1930	7.3	3.8	NA
1940	10.9	4.2	46.3
1950	10.6	4.3	39.1
1960	13.8	5.0	51.5
1970	19.9	5.5	83.5
1980	26.1	5.8	110.5
1990	33.0	6.8	110.0

Sources: D. Glasgow in W.S. Ellis and D.C. Turnley. "A Soviet Sea Lies Dying" in *National Geographic*, February 1990, and P. Micklin and W. Williams, *The Aral Sea Basin*, NATO, 1996.

Part 3: How has the region's landscape changed?

The Amu Darya and Syr Darya Rivers empty into the Aral Sea, which lies in an interior basin. The development of irrigation projects in the region, especially to grow cotton beginning in the 1950s, captured the river waters so that little fresh water reached the Aral Sea. Withdrawal of water from the Amu Darya and Syr Darya, primarily for irrigation, is the most important factor reducing water flows into the Aral Sea. This has caused the Aral Sea to shrink in size. How do you think the irrigation projects and the shrinking Aral Sea have affected the human populations that depended on it? Figure 5 offers some clues.

Figure 5: Abandoned Aral Sea fishing boats

Source: http://kidsat.jpl.nasa.gov/kidsat/photogallery/aral_ships.gif

Answer question 13 on the Log.

Increases in population, coupled with a demand for agricultural products, have resulted in a specific type of landscape (the entire set of human and physical features on Earth's surface that characterize a particular area or region) surrounding the Aral Sea. Figure 6 is a map of the Aral Sea. The rectangle to the east of the sea locates the image found in Figure 7. This image, a recent photograph taken from NASA's Space Shuttle, depicts land use surrounding the Syr Darya River. How does Figure 7 help you assess how human populations have affected the Aral Sea region?

Answer question 14 on the Log.

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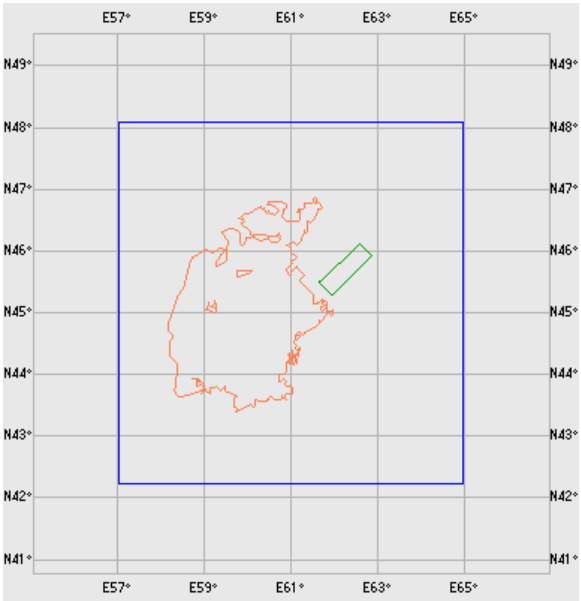

Figure 6: Aral Sea on geographic grid

Source: USGS—http://edcww.cr.usgs.gov/landaac…02086/lrlon=66.636154/result=13042

Figure 7: Land use east of the Aral Sea

Source: USGS—http://edcww.cr.usgs.gov/landaac…02086/lrlon=66.636154/result=13042

Part 4: What are the human consequences of the shrinking Aral Sea?

The shrinking Aral Sea has had both positive and negative human consequences. Agricultural production and irrigation increased, which improved the economy of the region. On the other hand, contaminated soil and water resulted from the use of chemical pesticides, herbicides, and fertilizers. Also, soils became saltier (salinization) and less suitable for agriculture. In addition, as the waters of the sea retreated, salty soil remained on the exposed lake bed. Dust storms blow away up to 75,000 tons of this soil annually, dispersing its salt particles and chemical residues into the air. This air pollution has caused widespread nutritional and respiratory ailments.

Government planners concerned with the human consequences of the shrinking Aral Sea have collected data for your team to analyze. Information on the fishing industry, health, and salinization have all been submitted for your consideration. In addition, predictions about the future size of the sea were submitted. Your team has been asked to make recommendations on how to address these problems and reduce the negative effects on populations in the region. You should make recommendations to regional governments for each type of effect listed below. Your recommendations should be based upon your hypotheses about why the sea has been shrinking.

Destruction of the Fishing Industry

As the Aral Sea has receded and the quality of the water reaching the sea has declined, there has been a sharp reduction in fisheries production (Table 3).

Table 3: Aral Sea Fish Catch, 1960-1990

Year	Metric Tons of Fish
1960	43,430
1965	31,040
1970	17,460
1975	2,940
1980	0
1985	0
1990	0

Source: M. Glantz, ed., *Creeping Environmental Problems and Sustainable Development in the Aral Sea Basin*, 1999, Cambridge University Press.

Table 4: Major Health Problems and Causes, Aral Sea Region

Disease/Affliction	Major Cause
Respiratory problems	Blowing salt and dust
Viral hepatitis	Contaminated water
Typhoid fever	Contaminated water
Cancer	Blowing salt and dust, toxic contaminants
Intestinal disorders and infections	Contaminated water, blowing salt and dust
Birth abnormalities	Toxic contaminants
Plague	Explosion of rodent population on dry sea bottom

Source: P. Micklin and W. Williams, *The Aral Sea Basin*, NATO, 1996

Today, no fish are caught commercially in the sea. Former ports to the south (Muynak) and the north (Aralsk) of the sea are stranded many miles from the receding shoreline. The loss of the Aral Sea's fisheries sparked the collapse of the entire industry, causing unemployment and the decline of economies of former coastal towns.

Health Problems

The dependence of countries surrounding the Aral Sea on cotton production and irrigation using the waters bound for the Aral Sea has had a major impact on human health. Large-scale pesticide and fertilizer use has resulted in groundwater contamination, and many fertilizer and pesticide residues have been blown from the exposed lake bed across the landscape. The widespread regional health effects include dramatic increases in many types of health problems (Table 4).

Salinity Increases

The shrinking size of the Aral Sea has also increased the *salinity* (salt content) of the waters of the sea (Table 5). In the 1960s, the water was drinkable and supported a wide variety of fresh water animals and plants used by humans. Today, the sea water is undrinkable: it is saltier than the open ocean.

Table 5: Salinity of the Aral Sea, 1960-1995.

Year	Average Salinity (grams per liter of water)
1960	10
1970	11
1980	22
1990	37
1995	50

Source: P. Micklin and W. Williams, *The Aral Sea Basin*, NATO, 1996

Size of the Aral Sea

Figure 8 gives a chronology of the size of the Aral Sea from 1960 to 2010.

Your team should conclude its investigation by summarizing what it has learned about the Aral Sea and by making recommendations in a final report to NASA on the Log.

Answer question 15 on the Log.

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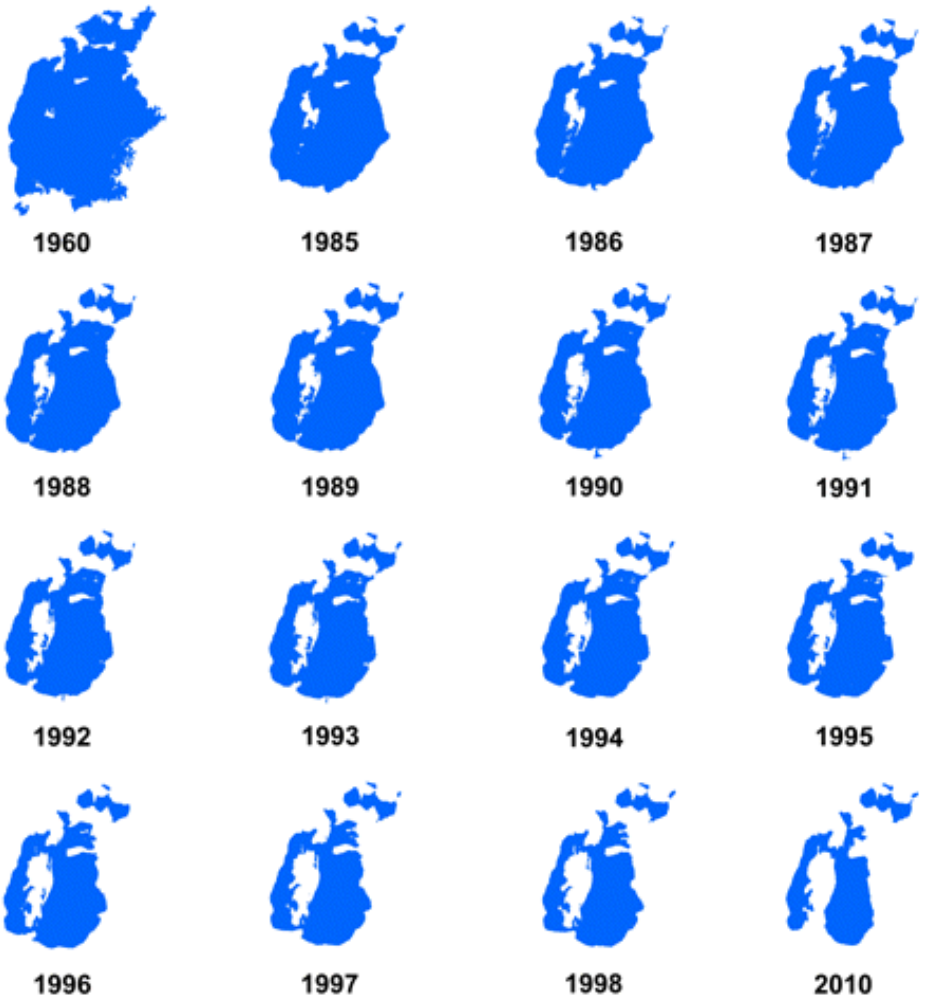

Figure 8: Chronology of the size of the Aral Sea
Source: German Department of Defense (http://www.dfd.dlr.de/app/land/aralsee/chronology.html)

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USGS SIR-C browse, coverage map, and scene metadata http://edcwww.cr.usgs.gov/landaac…02086/lrlon=66.636154/result=13042

Module 1, Investigation 2: Log
What is happening to the Aral Sea?

1. What is the latitude and longitude at the center of the Aral Sea? _____

2. What countries surround the Aral Sea? _____

   _____

3. What was the surface area in square kilometers of the Aral Sea in 1964?

   _____

4. What was the surface area in square kilometers of the Aral Sea in 1997?

   _____

5. What was the percentage change in the surface area of the Aral Sea from 1964 to 1997? _____

6. How did the satellite imagery help you to draw conclusions about changes in the Aral Sea?

   _____

   _____

7. Name the two major rivers that flow into the Aral Sea.

   _____

8. List your hypotheses about physical processes that have caused the Aral Sea to shrink.

   _____

   _____

   _____

9. List your hypotheses about human processes that have caused the Aral Sea to shrink.

   _____

   _____

   _____

10. Fill in the blanks below (with the words *increasing* or *decreasing*) to indicate what has been happening to the Aral Sea.

    The data in Table 1 show that the Aral Sea has been _____ in surface elevation, precipitation has been _____, evaporation has been _____, annual river flow has been _____, and the volume of the sea has been _____ .

11. What physical processes might explain the changes in precipitation and evaporation shown in Table 1? _____

    _____

    _____

    _____

    _____

    _____

Module 1, Investigation 2: Log
What is happening to the Aral Sea?

12. In the space below, graph the data in Table 2 to illustrate the relationship between irrigation in the Aral Sea region and population growth. Include in your graph your projections for the years 2000 and 2010. Write a brief description of the relationship(s) below your graph.

13. How has the shrinking of the Aral Sea affected the human populations in the region?

_____

_____

_____

14. What types of human activity can you detect from the Space Shuttle image in Figure 7?

_____

_____

_____

15. Final Team Report. Briefly describe what has happened to the Aral Sea. Indicate how human consequences have been related to the decline in the size of the sea. You should also make predictions about what will happen in the future. Finally, make recommendations for government planners on how to reduce the environmental problems of the region and how to manage the region's water resource and stabilize the Aral Sea.