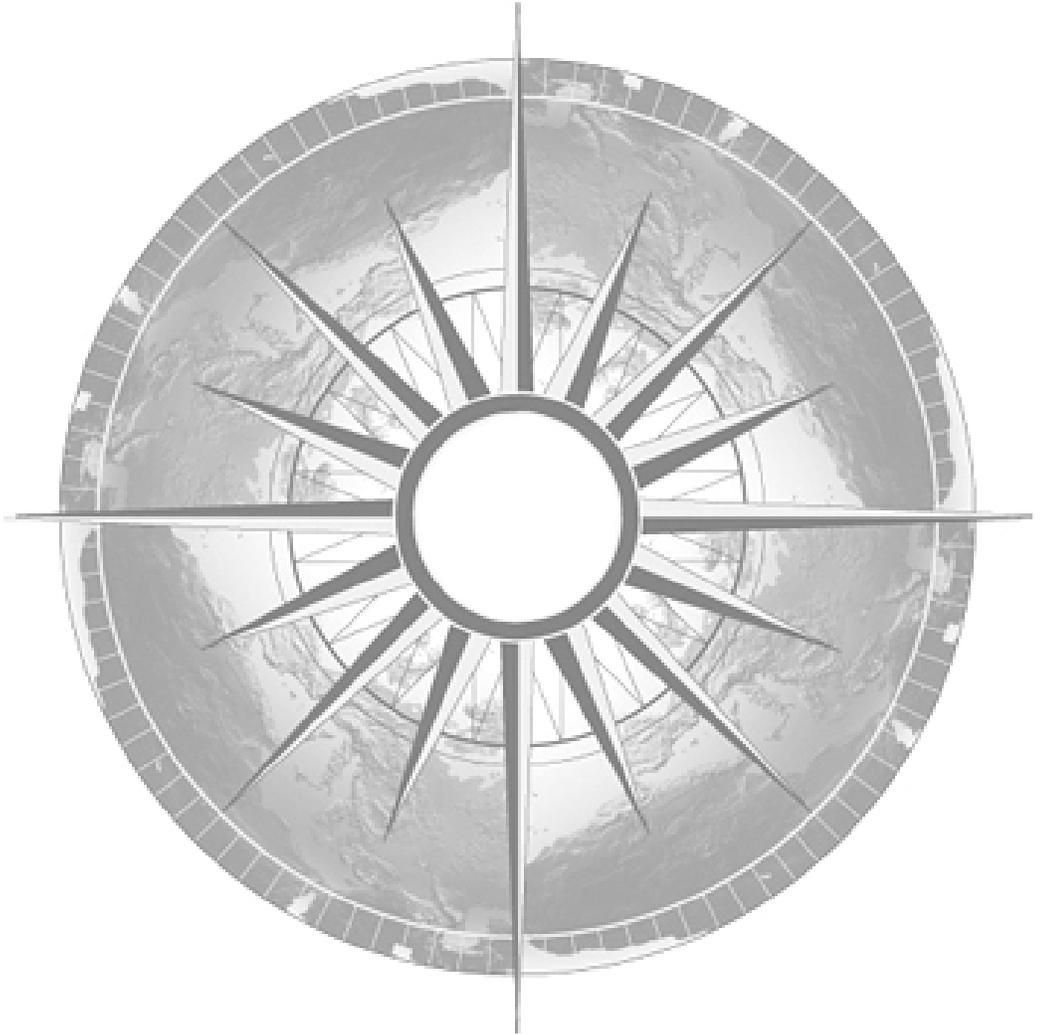


HEMISPHERES

People and Place Curriculum Resources on Human-Environmental Interactions

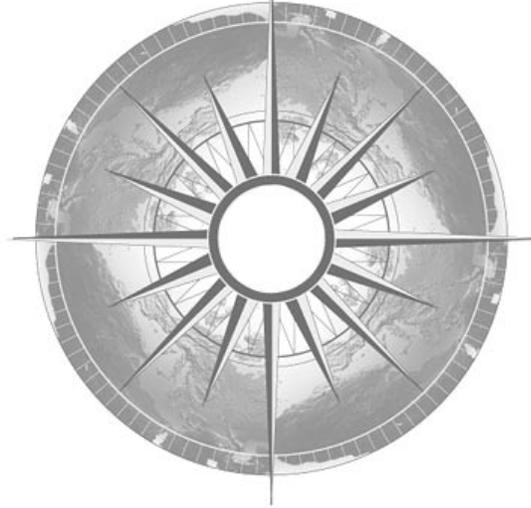


Hemispheres is a joint project of:
Teresa Lozano Long Institute of Latin American Studies
Center for Middle Eastern Studies
Center for Russian, East European & Eurasian Studies
South Asia Institute

in the College of Liberal Arts
at The University of Texas at Austin

People and Place

Curriculum Resources on
Human-Environmental Interactions



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People and Place
Curriculum Resources on
Human-Environmental Interactions

Final Version

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TEACHER NOTES

GOALS

This case study will help your students understand the interrelationships between lakes and rivers. By studying the changes in the Aral Sea, they will understand that: (1) lakes are affected by both the quantity and the quality of water that flows into them from rivers; (2) damming or diverting rivers, for irrigation and other purposes, can have a significant impact on the size and water-quality of lakes; (3) the negative effects (including environmental, social, economic, and health) of disappearing natural resources are varied and complex; and (4) water is not an infinite resource and must be managed carefully.

ASSESSMENT EVIDENCE

Fish or cotton?: Role-playing activity in which students take on the roles of citizens whose lives have been affected by the Aral Sea and discuss the impact the changes in the sea level have had on them.

LEARNING ACTIVITIES

- *For the Common Good* will enable students to understand the concept that consensus and cooperation, rather than individualistic approaches, have better results when using resources.
- With the *Introduction to the Aral Sea* reading and comprehension worksheet, students will learn the names of the countries that border the Aral Sea, what activities have led to the reduction in water flow into the Aral Sea, and some of the consequences.
- *The Disappearing Sea: Maps of the Aral Sea Then and Now* shows the changes between 1960 and 2000. For a stronger visual, trace the outlines on transparencies and project the 1960 image, then overlay the 2000 image. Satellite images also show the significant changes in the sea.
- *The How Great Are the Great Lakes?* graphing activity compares the size of the Aral Sea with that of the Great Lakes. Students can also do research on the size of lakes near their town or city to include in the graph.
- The *Where Has All the Water Gone?* reading and graphing activity will show students how a decrease of inflow has caused the balance of water in the Aral Sea to change. With the aid of the teacher, students can brainstorm ways in which flow to the Aral Sea could be increased (some options: reduce the amount of land under cultivation, change crop choice to one that requires less water, make sure water used for irrigation isn't wasted [line canal bottoms so water doesn't sink into the ground before it gets to the fields, cover canals to limit evaporation], reuse wastewater, etc.).
- *The Aral Sea in the News* includes excerpts from news articles and commentary about the ways in which the drying up of the Aral Sea has affected local populations who used to depend on the sea for their livelihoods, and various possible solutions to the continuing problem.
- *Further Information* contains links to other sources of information for further research.

For the Common Good

Introduction:

Renewable resources, such as water, trees, or fish, can be maintained if managed properly. But these resources can be exhausted quickly as the demand for the resources grows. In managing these resources, it is important for people to use them cooperatively and not to sacrifice long-term gain for short-term profits. In the first part of this activity, students play a game where cooperative decisions must be made if all are to benefit. Note: It is best to play the game first without telling the students that the chips represent resources that must be shared.

Materials:

Tokens (such as poker chips or peanuts in the shell)
10 tokens per student should be available altogether
Hard candies, stickers, or something the students value highly
Stopwatch or watch with a second hand
CD or tape player for playing music
CD or tape of lively music
Paper and pencils or pens

Something for Everyone

Procedure:

- (1) Count out, but do not distribute, 10 chips for each student playing the game. Put one-fourth of them in a separate pile.
- (2) Seat the students in a circle.
- (3) In the center of the circle, place the pile comprising one-fourth of all the chips. For example, if you have 10 students, you use 100 chips and begin with 25 in the center.
- (4) Read the following rules twice to the students.

Rules:

- (1) The chips belong to all of you.
- (2) Music will be played, and while it is playing, everybody may take chips out of the pool of chips in the center.
- (3) You may trade in 10 chips for a piece of candy (or sticker).
- (4) As soon as the music stops, I will double the number of chips left in the pool at that time, and then continue the game.
- (5) There will never, however, be more chips in the pool than there are at the start of the game; this is the maximum number of chips the pool can hold.
- (6) You may not talk to anyone during the game.

Notes to the Teacher: DO NOT explain the significance of the chips before playing the game. The rules are the only instructions the players get.

The players will most likely empty the pool at the start of the game. Point out that, as it's impossible to double zero, the game is over. Ask if they'd like to try again. Each student must return all of his/her chips to the pool.

Continue to play the game for several rounds without giving the students time to communicate with one another in between.

When doubling the chips in the pool, remember there can “never be more chips in the pool than at the start of the game.” This is the pool’s *carrying capacity* for chips.

After several rounds, you may allow the students to talk while the music plays so they can discuss strategies.

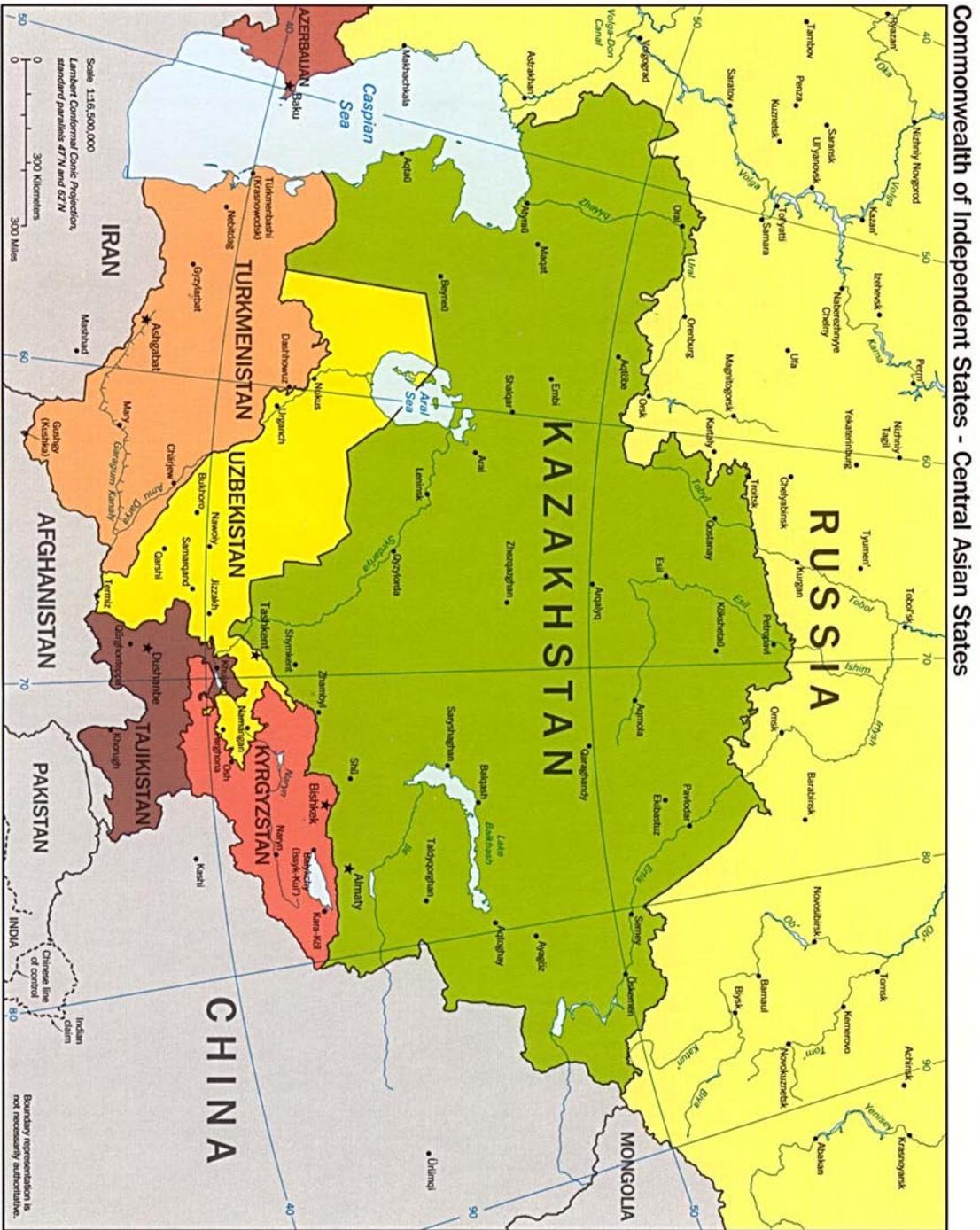
After five or six rounds, ask students how they feel about the way the game worked out. As a group, help students think of ways they could cooperate to allow more of them to get their 10 chips without depleting the pool of resources. Play again using the strategies developed by the students.

Discussion Questions:

- (1) What do the chips represent? (*Renewable resources*)
- (2) Can we draw any parallels between the way the group treated the chips and the way individuals and society as a whole use or overuse renewable resources?
- (3) How many chips were taken out of the pool in the different game variations? How many candies did this generate? How did it make you feel about other members of the group?
- (4) How did talking about the game make you play differently? After discussing strategies, did it seem that differing attitudes were behind the different ways you played the game? Why did some players take as many chips as they could and others left some behind? How did this make you feel?
- (5) Have you experienced a similar situation at home, with friends, in your community? (*It may help to provide an analogy, such as several people in the house competing for hot water in the morning.*) How, in the long run, can more benefit if individuals refrain from taking too much? What sort of attitude do we need to have to achieve the goal of the greatest benefit for all?

Source: 1996. *People and the Planet: Lessons for a Sustainable Future*. Washington, DC: Zero Population Growth, Inc. 144-146.

Map of Central Asia



Source: Perry-Casteneda Library Map Collection, University of Texas at Austin, http://www.lib.utexas.edu/maps/commonwealth/cis_central_asia_pol_95.jpg

Introduction to the Aral Sea

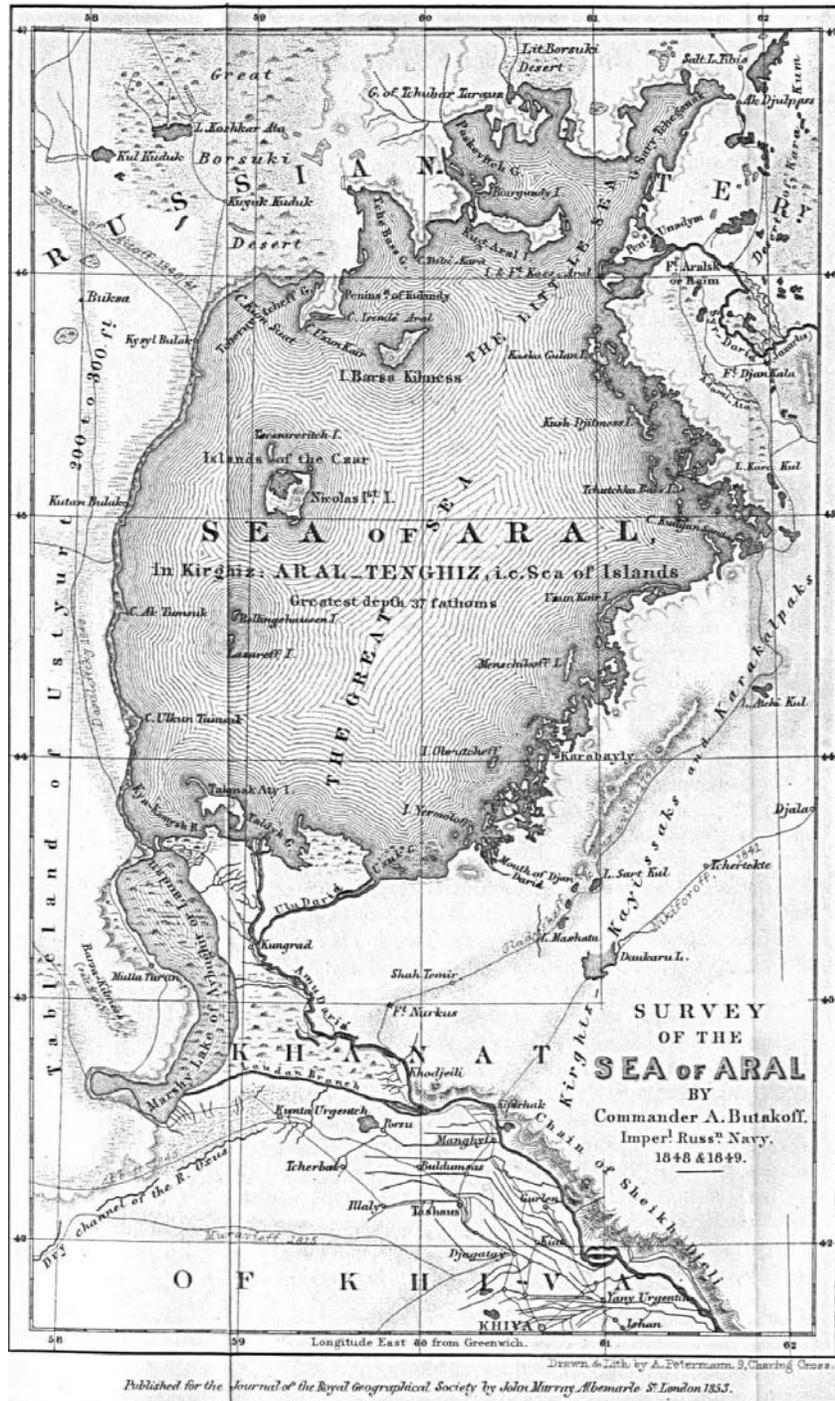
The Aral Sea is more than 5 million years old and was once the fourth largest lake in the world. Fed by two mighty rivers, the Amu Darya and the Syr Darya, it seemed a limitless source of water. Just 40 years ago it was more than 250 miles long and almost 200 miles wide. Since then, the lake has shrunk to 1/3 its original capacity. How could this happen?

In the 1960s, the Soviet Union, of which Kazakhstan and Uzbekistan were a part, decided to increase agriculture in the region. Cotton was chosen as the major crop. The general climate of Central Asia is dry (*arid*), and it was necessary to irrigate the fields, therefore water was taken from the Amu Darya and the Syr Darya rivers. These rivers begin in the mountains of Kyrgyzstan and Tajikistan and flow through parts of Turkmenistan, Uzbekistan, Karakalpakstan (an independent region of Uzbekistan), and Kazakhstan.

Some experts predicted that diverting water from the rivers would cause the level of the Aral Sea to go down, but others said that it would be a more productive use of water and land to have irrigated fields and a product that could be sold. In fact, cotton production was very successful, and remains one of Uzbekistan's largest export products. However, the methods of irrigation (including unlined canals and poor drainage) led to water wastage. Overuse of pesticides and fertilizers on the fields polluted the groundwater. Agricultural development led to population increases, as more people were needed to work the fields. More people meant yet more water usage. Between 1960 and 1980, the water flowing into the Aral Sea was reduced by 50%; by now it has been reduced almost 90%.

The current state of the Aral Sea is critical. As less and less water flows into the sea, the level of the sea has dropped, the overall volume has decreased, and the shoreline has receded. Towns that once stood on the coast are now more than 70 kilometers from the sea. Land that used to be under water is now exposed to the air, and wind blows surface minerals for miles. The minerals in the water are more concentrated and salt content (*salinity*) has increased 400%, killing most fish and wildlife. For decades the major countries affected by the desertification of the Aral Sea and the rivers that flow into it have been discussing ways to better manage water use. Their discussions continue today.

The Disappearing Sea: Maps of the Aral Sea Then and Now



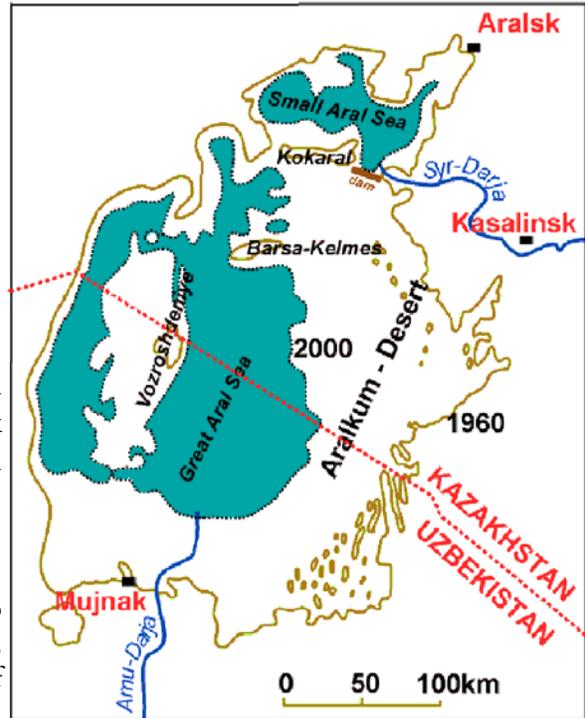
This is one of the earliest maps of the Aral Sea, made by Russian explorers in 1848 and 1849. Note that it is a large sea with a number of small islands.

Source: “Survey of the Sea of Aral by Commander A. Butakoff, Imperial Russian Navy, 1848 & 1849” from the Journal of the Royal Geographical Society, Vol. 23, 1853 to accompany “Survey of the Sea of Aral” by Commander Alexey Butakoff. Perry-Castañeda Library Map Collection, University of Texas at Austin, http://www.lib.utexas.edu/maps/historical/aral_1853.jpg

The Disappearing Sea: Maps of the Aral Sea Then and Now cont.

This map shows the outline of the Aral Sea in 1960 and the outline in 2000. Aralsk and Muinak are towns in which fishing used to be the main industry.

Courtesy of Dr. Siegmur Breckle.
 Source: German Competence Network for Research to Combat Desertification,
<http://www.desertnet.de/aralsea.gif>



July - September, 1989



August 12, 2003

These photographs were taken by satellite in 1989 and 2003. Vozrozhdeniye Island used to be used as a secret military weapons testing base because it was inaccessible and easy to protect.

Source: NASA's Earth Observatory, http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=16277

How Great Are the Great Lakes?

In order to better understand the magnitude of the changes taking place in the Aral Sea, take a look at some large bodies of water here in the United States—the Great Lakes.

The Great Lakes are a series of five lakes in North America that are located in both the United States and Canada. The Great Lakes hold 20% of the world's fresh water. The Great Lakes, too, are facing challenges in terms of water diversion, although their levels change much less and they are not threatened with destruction. The Great Lakes also have problems such as pollution and invasive species (non-native plants or animals that can change the ecosystem). While each state and country has its own interests in the Great Lakes, many local organizations monitor their status, and the Great Lakes Information Network (GLIN) is a partnership that provides an online resource for people to find information on the Great Lakes–St. Lawrence region of North America.



Source: Great Lakes Information Network, <http://www.great-lakes.net/lakes/> (Reprinted with permission.)

Comprehension Exercises

(Look in an atlas for a more detailed map of the Great Lakes with cities indicated.)

- (1) What countries surround the Great Lakes? Which U.S. states are in the Great Lakes watershed?
- (2) What challenges and problems do the Great Lakes face?
- (3) Are the Great Lakes salty or fresh?
- (4) Where does the water in the Great Lakes come from?
- (5) Name 5 major cities near the Great Lakes.
- (6) Look at a map of your state and determine the largest body of water. What relationship does your town or city have with that water (*recreation area, reservoir feeder for drinking water, wildlife habitat, etc.*)? What is the source of its water supply (*underground spring, river, mountain snow runoff*)?
- (7) Brainstorm some businesses that might be associated with that body of water (*boat rental, beach-side restaurant, ice cream stand, parking lot, nature tour service*). What do you think would happen to those businesses if the river dried up or the lakeshore moved farther away?

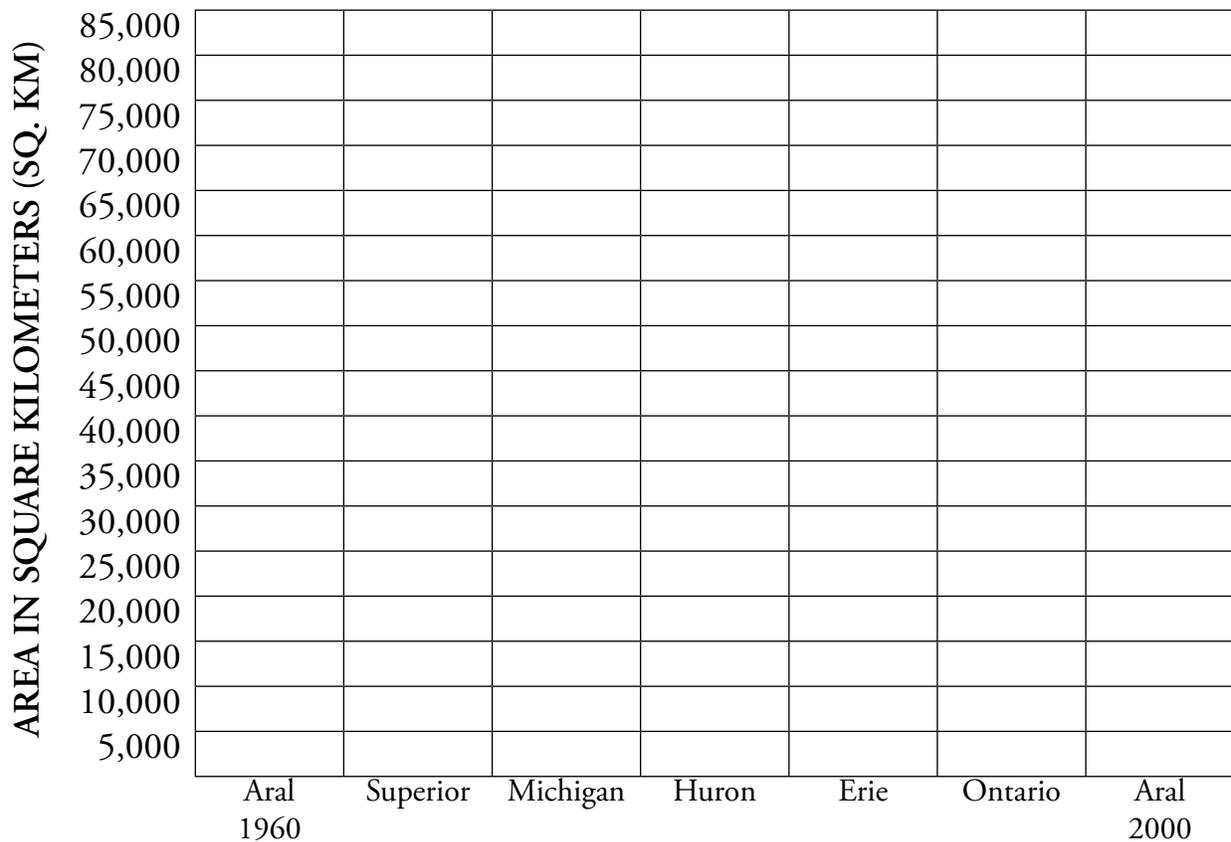
Name: _____

The Aral Sea and the Great Lakes
Graph Activity

Using the information below, create a bar graph showing the area of the Aral Sea in 1960, the Aral Sea today, and the Great Lakes today.

	Length (km)	Breadth (km)	Area (sq. km)	Volume (km ³)
Aral Sea 1960	420	280	66,458	1,064
Lake Superior	563	257	82,100	12,100
Lake Michigan	494	190	57,800	4,920
Lake Huron	332	245	59,600	3,540
Lake Erie	388	92	25,700	484
Lake Ontario	311	85	18,960	1,640
Aral Sea 2000	Now two separate basins		23,400	400

Source: Great Lakes information, <http://www.epa.gov/glnpo/atlas/gl-fact1.html>

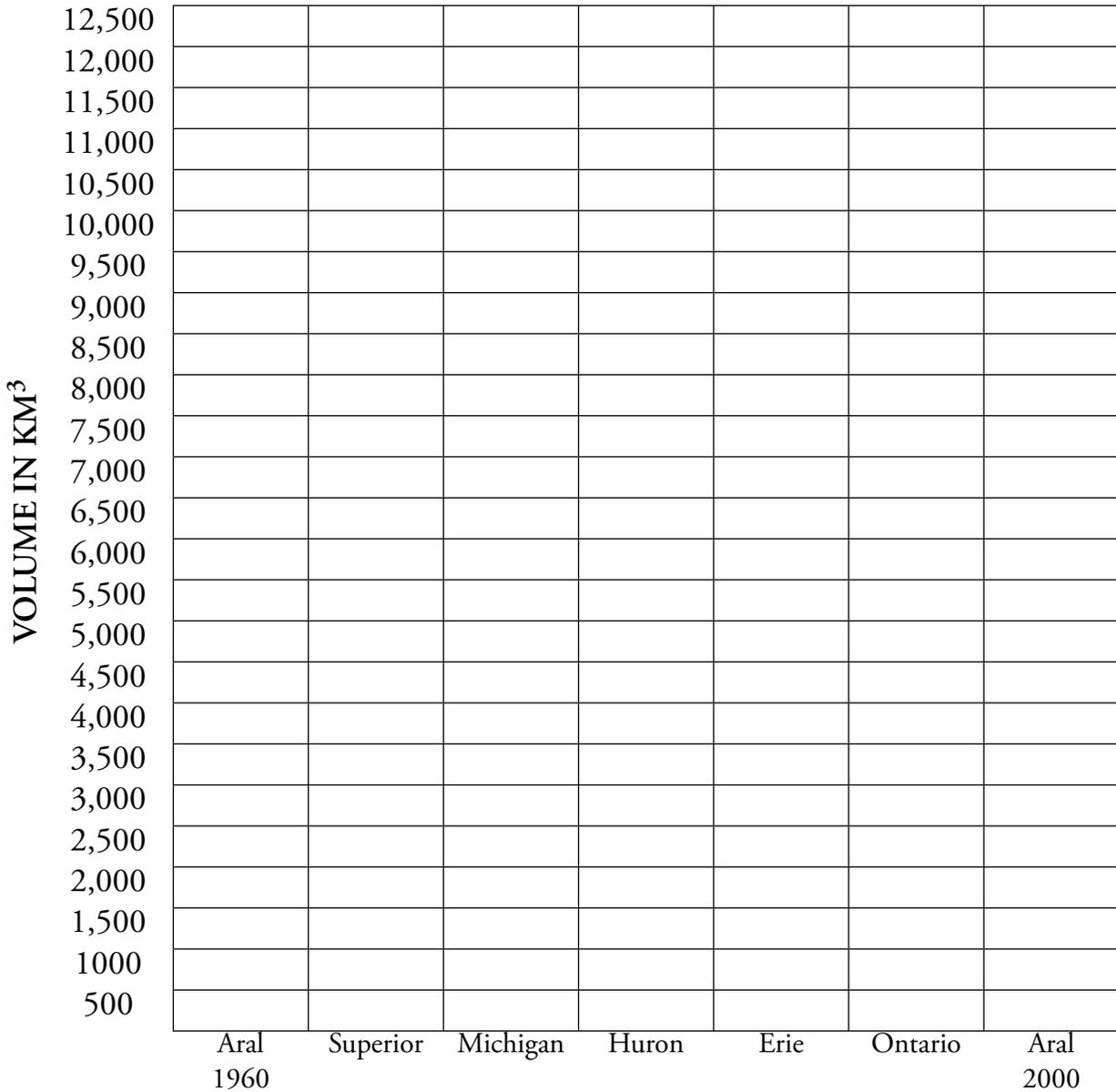


Comprehension Exercises

- (1) Which lake is the largest? Smallest?
- (2) How has the area of the Aral Sea changed in the past 40 years?
- (3) What might be the effects on Chicago if Lake Michigan shrank by 75%?

The Aral Sea and the Great Lakes
Graph Activity (cont.)

Area is just one of many ways by which lakes can be compared. Using the information on the previous page, create a graph showing the volume of the lakes. Then answer the questions below.



Comprehension Exercises

- (1) List the lakes in order from largest to smallest. Are they in the same order as when you compared them by area?
- (2) Why might a lake have a smaller surface area, but a larger volume?
- (3) How would a reduction in water volume affect a deep sea? How would it affect a shallow sea?

Name: _____

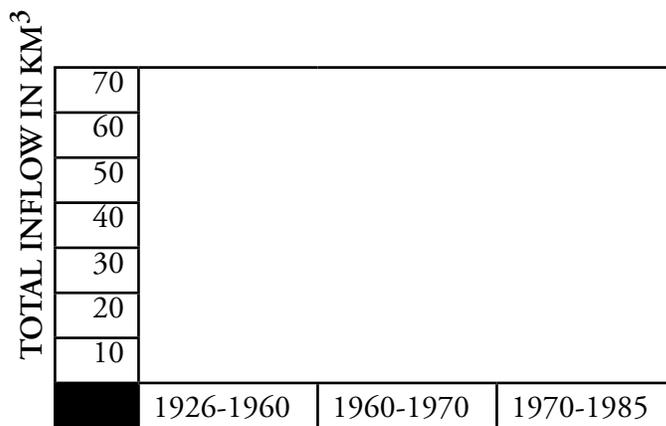
Where Has All the Water Gone?

The Aral Sea receives water from three sources: the Amu Darya River, the Syr Darya River, and rainfall (*precipitation*). The sea has no outflow (no rivers which flow out of it), so the only natural water loss comes from evaporation. In 1900 approximately 3 million hectares of land in the area were under cultivation. Before 1960, the level of the Aral Sea was more or less stable. However, in the 1960s when planners decided to increase the area of cotton cultivation, canals were built to redirect water from the rivers and into the fields. As demand for cotton exports increased, more land was used, more water was diverted, and less water flowed into the sea. Between 1960 and 1980, more than 4 million additional hectares of land were put under cultivation, essentially doubling the irrigated territory and the amount of water taken out of the rivers. One of the longest irrigation canals is the Karakum Canal, which goes from the Amu Darya towards the west about 1300 km, into the Karakum Desert.

Look at the table below and create a line graph showing the decrease of inflow into the Aral Sea from 1926–1985.

Period	River inflow (km ³)	Precipitation (km ³)	Total inflow (km ³)	Evaporation loss (km ³)
1926-1960	55.2	8.2	63.4	64.1
1960-1970	42.8	8.4	51.2	63.3
1970-1985	16.3	6.6	22.9	56.2

able statistics: The Center for International Earth Science Information Network (CIESIN), <http://www.ciesin.org/docs/006-238/006-238.html>



Comprehension Exercises

(1) How much annual inflow (km³) is needed to keep the level of the Aral Sea from shrinking any further?

(2) Brainstorm ways that inflow can be increased.

The Aral Sea in the News

Reading 1

“In arid areas, water is an invaluable gift of nature. All of life depends on water—life comes to a halt where water has vanished. And water resources in Central Asia are extremely limited. It is not surprising that nowadays all the water resources of the Aral Sea basin region [...] are fully consumed by the national economies. Because the watershed for the region is mostly located in the mountains of Kyrgyzstan and Tajikistan, and most of the water resources are used for irrigation by the Central Asian republics, it is necessary to have joint and coordinated management of the limited water resources of the entire Aral Sea basin region in the interests of all the states of the region. This management must also meet ecological requirements to provide water to the rivers’ delta and to the Aral Sea itself.”

Excerpted from: Islam Karimov. 1997. *Uzbekistan on the Threshold of the Twenty-First Century*. Surrey: Curzon. 75-77.

Reading 2: Kazakh fishing port haunted by ghost of dying sea

ARALSK - Aralsk is the town that time forgot. Dilapidated factories stand silent and crumbling. Rusty cranes loom over a bleak landscape, which is littered with fragments of broken and abandoned machinery.

Its port, once the pride and joy of its residents, is dry and empty. No fish, cargoes or boats come through here anymore. Fishermen are an endangered species. It is only the eerie, rusting hulks of ships and the salt-encrusted earth that are testament to a sea that once lapped at the very edges of the town.

People in Aralsk say it has been more than 25 years since they could see the Aral Sea, and now the once-thriving port resembles nothing more than a huge, rubbish-strewn sand pit.

Enquiries as to the whereabouts of the water are treated like a bad joke. “The sea? What sea? We don’t have a sea here anymore,” said a man disembarking at Aralsk’s train station. Behind him a huge mural shows how the people of Aralsk provided fish for a hungry nation on Bolshevik leader Vladimir Lenin’s request.

The Aral Sea, which straddles the former Soviet Central Asian republics of Uzbekistan and Kazakhstan, is dying. And the former fishing port of Aralsk is fading along with it.

The water-thirsty region has two great rivers, the Syr Darya and the Amu Darya, which used to feed the Aral Sea. But in the 1960s Soviet planners built a network of irrigation canals to divert their waters into cotton fields in Uzbekistan and Turkmenistan, starving the sea of its life blood. Now a mere trickle reaches the sea, and the water that does is contaminated by the residues of pesticides, fertilisers and defoliants used on the cotton fields.

Dying Sea Bleeds Town Dry

Once the world’s fourth largest lake, the Aral has shrunk so much that it has now split into two separate bodies of water—the northern or ‘little Aral Sea’ and a larger southern body.

“We didn’t realise what was happening at first,” said local resident Gulzhikhan Abdulgazyeva. As a clanging metallic noise echoed across the port-turned-dust bowl, she sighed and said: “That used to be a repair shop for barges and boats. Now they only fix cars.”

It is not only the fishing and shipping industries that have suffered from the sea’s disappearance. Textile and electronics factories lie empty and the town mill does not work anymore. Desertification and high salt levels are damaging agriculture.

The town of Aralsk is home to around 39,000 people and the Aralsk region around 68,000. It has one of the highest unemployment levels in Kazakhstan. “We have lots and lots of unemployment here. I myself sat for three years without work,” Gulzhikhan said. She now does some work at the town’s tiny, private guest house. “But we have very few entrepreneurs like (the hotel boss). If we had more maybe we would have less unemployment.”

Health Problems

The United Nations Development Programme (UNDP) has been running an Aral Sea Programme since 1995. It focuses mainly on water resources management, small business development, humanitarian assistance and a social and health programme.

For the ecological disaster of the dying sea has brought climate change—colder winters and hotter summers—to the region and a host of associated health problems. UNDP says anaemia in women, tuberculosis and high infant mortality are among the major health issues. Incidences of cancer and respiratory diseases have also risen.

“We have lots of health problems now because of the ecological situation...deformed kids are born,” Gulzhikhan said.

And everyone you meet in Aralsk warns of rising crime blamed on unemployment.

Aralsk’s museum is like an obituary to the town’s former livelihood. Curator Rysbek Akimov proudly shows off the seashell fossils and fish teeth stacked in glass cases and enormous pickled fish stare out of jars.

“Once upon a time people all over the Soviet Union bought our fish. They were very tasty fish even though it was a small sea,” he said wistfully.

Sergei Sokolov, UNDP national project manager in Aralsk, says it is now around 90 kilometres (55 miles) from Aralsk to the sea.

Source: Planet Ark Reuters World Environment News Service, <http://www.planetark.com/dailynewsstory.cfm/newsid/15390/story.htm>

By Tara FitzGerald, 4/9/2002.

Reading 3: Aral Sea poison dust danger

Researchers have discovered that contaminated dust from the Aral Sea has blown hundreds of kilometres across Central Asia, raising new concerns about the consequences for human health. The study, by a team from the UK, found that some of the highest deposits from the old Aral seabed are in southern Turkmenistan, far away from the epicentre of what's been described as the world's worst man-made environmental disaster.

The researchers from Nottingham University say the devastating impact on human health needs to be urgently assessed.

For years now, people living around the Aral Sea have been suffering from the toxic cocktail of pesticides and salts that blow off the old seabed.

The Aral used to be the fourth largest inland sea in the world, but the Soviets siphoned off the waters that feed it to irrigate the vast cotton fields of Central Asia. As a result, the Aral Sea shrank by almost half, leaving a toxic wasteland that has blighted the land and its people.

For the first time, this new study shows just how wide the area is of those affected by the polluted dust that now blows off the old seabed—and how deadly are the pesticides and salts they carry.

Health concerns

The researchers collected dust samples from as far away as Turkmenistan's border with Afghanistan, hundreds of kilometres to the south. And worryingly, it was in the areas furthest away that they found the highest concentrations of dust.

Ian Small, the director of Medecins Sans Frontieres in Uzbekistan, said: "The region has one of the highest rates of acute respiratory infections in the world. It's estimated that, if and when the sea completely dries up, there will be 15 billion tonnes of salt liberated into the environment. So clearly, the problem is getting worse and we need to determine what is the human health effect."

Already it has been suggested that the toxic dust from the Aral has been carried as far as the Himalayas and Belarus.

There are also concerns that the high salt content is contributing to the melting of glaciers high in the Pamir Mountains, where Central Asia meets Afghanistan and from where the rivers that feed the Aral Sea flow.

Source: BBC News Online, <http://news.bbc.co.uk/1/hi/world/asia-pacific/647732.stm>
By Central Asia Correspondent Louise Hidalgo, 2/18/2000.

Name: _____

The Aral Sea in the News
Comprehension Exercises

- (1) What was the main industry of the town of Aralsk 25 years ago? What is the main industry today?

- (2) How have citizens in Aralsk adapted to the changes brought about by the shrinking of the sea?

- (3) What sort of health problems are people facing in the region?

- (4) How many countries are affected by the changes in the Aral Sea?

- (5) Why are international organizations interested in working in the area?

Fish or Cotton? Role-Playing Activity

Divide the class into 4 groups and assign each group one of the following cards. Have the students discuss their point of view within their groups and then prepare a statement regarding the importance of their situation to present to the class.

Role-Playing Cards

<p>You are an Uzbek government official.</p> <p>The export of cotton is very important to your country. Higher exports bring in more money, which means a higher standard of living for your citizens. Irrigation of the cotton fields is essential in order to keep up your production levels.</p>	<p>You are a citizen living in Aralsk.</p> <p>Your family used to be fishermen, but your town is now 60 miles from the sea. You've worked at odd jobs, but haven't had a good-paying job in 5 years. You've heard that the Caspian Sea is rising—why not redirect that water to the Aral so the sea could be restocked with fish?</p>
<p>You are a doctor in Karakalpakstan.</p> <p>In recent years you've seen more and more cases of anemia, cancer, and respiratory infections. You suspect the toxic dust blowing from the seabed is causing the problems.</p>	<p>You are a cotton farmer in Kazakhstan.</p> <p>The soil in your field is not very good, and to ensure a good crop of cotton, you need to enrich it with fertilizer. Your family depends on the cotton crop for its livelihood.</p>

Further Information on the Aral Sea

LakeNet is a global network of people and organizations in more than 90 countries dedicated to the conservation and sustainable development of lake ecosystems: <http://www.worldlakes.org/lakedetails.asp?lakeid=9219>

The Water Page is an independent initiative dedicated to the promotion of sustainable water resources management and use: <http://www.thewaterpage.com/aral.htm>

The Web site of Environmental Health Perspectives (EHP) is a peer-reviewed open access journal dedicated to the effect of the environment on human health. EHP is a publication of the Public Health Service, U.S. Department of Health and Human Services, National Institutes of Health, and National Institute of Environmental Health Sciences (NIEHS): <http://ehp.niehs.nih.gov/members/2001/109p547-549small/small-full.html>

AQUASTAT is a global information system on water and agriculture developed by the Land and Water Development Division of FAO (Food and Agriculture Organization of the United Nations). The objective of AQUASTAT is to provide users with comprehensive information on the state of agricultural water management across the world, with emphasis on developing countries and countries in transition: <http://www.fao.org/waicent/FaoInfo/Agricult/AGL/AGLW/aquastat/regions/fussr/index8.stm>

More information on the Great Lakes can be found through the Great Lakes Information Network: <http://www.great-lakes.net/>

Satellite images of the Aral Sea. The purpose of NASA's Earth Observatory is to provide a freely-accessible publication on the Internet where the public can obtain new satellite imagery and scientific information about our home planet. The focus is on Earth's climate and environmental change: http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=16277

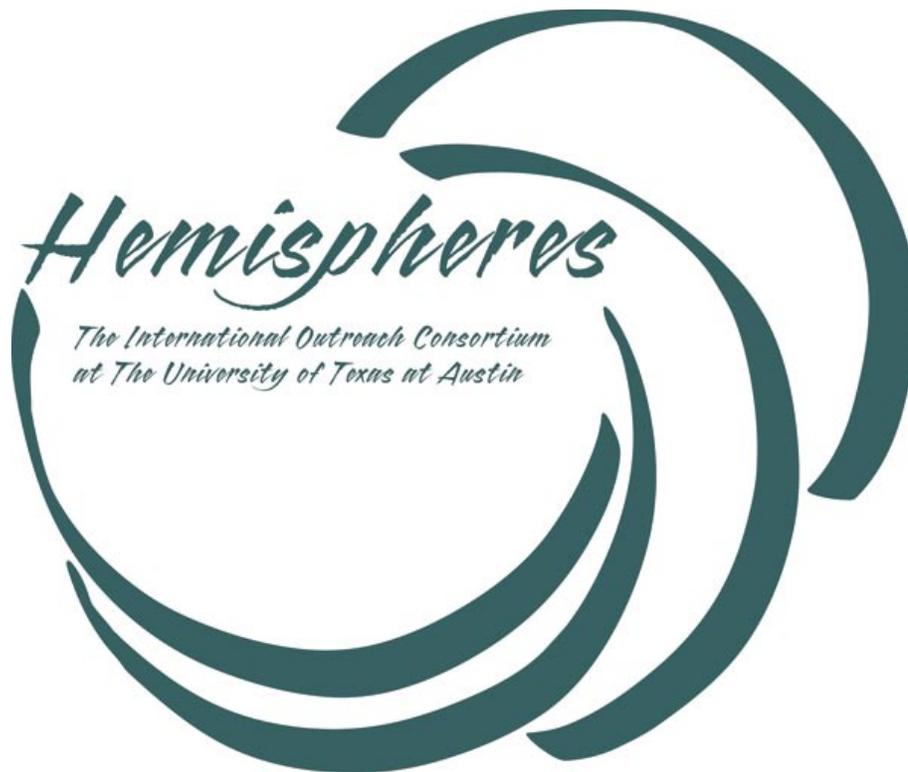
About Hemispheres

Created in 1996, Hemispheres is the international outreach consortium at the University of Texas at Austin. Hemispheres utilizes University resources to promote and assist with world studies education for K-12 and postsecondary schools, businesses, civic and non-profit organizations, the media, governmental agencies, and the general public.

Comprised of UT's four federally funded National Resource Centers (NRCs) dedicated to the study and teaching of Latin America; the Middle East; Russia, East Europe & Eurasia; and South Asia, Hemispheres offers a variety of free and low-cost services to these groups and more. Each center coordinates its own outreach programming, including management of its lending library, speakers bureau, public lectures, and conferences, all of which are reinforced by collaborative promotion of our resources to an ever-widening audience in the educational community and beyond.

Hemispheres fulfills its mission through: coordination of pre-service and in-service training and resource workshops for educators; promotion of outreach resources and activities via exhibits and presentations at appropriate state- and nation-wide educator conferences; participation in public outreach events as organized by the consortium as well as by other organizations; and consultation on appropriate methods for implementing world studies content in school, business, and community initiatives.

For more information, visit the Hemispheres Web site at:
<http://www.utexas.edu/cola/orgs/hemispheres/>
or e-mail: hemispheres@austin.utexas.edu



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