The Aral Sea Disaster

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Ancient Khorezm
(southern delta of the Aral Sea)
• Overview: the Aral Sea Disaster
• What happened?
• Effects
• Why did this happen?
• What is being done?
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The Aral Sea
The Aral Sea
Aral Sea
World’s 4th Largest Lake
Not A Sea
Central Asia
Water in the Desert Steppe
“It is clearly one of the worst environmental disasters of the world…it is a vivid testament to what happens when we waste our common natural resources, when we neglect our environment, when we mismanage our environment.”

-- Ban Ki-moon, United Nations Secretary-General, April 2010
Resources:

• Live Earth video, The Aral Sea
  – http://www.youtube.com/watch?v=NC5UIEx83fo&feature=player_embedded

• Al Jazeera report, The Aral Sea Reborn
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Why did the Aral Sea disappear?

1. Increases in irrigation agriculture throughout the 20th century used up all of the water before it could reach the sea.
The Aral Sea

Tien Shan

Pamirs

Hindu Kush

Himalayas
What has happened...

1957 from a map
1977 from satellite images
1982 from satellite images
1984 from satellite images
1993 from a map
November 2000 from satellite images

In 1989-1990, the Aral Sea separated into two parts: the "Large Aral" and the "Small Aral"
Why did the Aral Sea disappear?

1. Increases in irrigation agriculture throughout the 20th century used up all of the water before it could reach the sea.

2. Farmers grew crops that required lots of water → cotton monoculture.
Why did the Aral Sea disappear?

1. Increases in irrigation agriculture throughout the 20\textsuperscript{th} century used up all of the water before it could reach the sea

2. Farmers grew crops that required lots of water $\rightarrow$ cotton monoculture

3. Excessive use of agricultural pesticides polluted the environment
**DDT**
- Pesticide used extensively in the 20th century
- Outlawed in U.S. in 1970's
- outlawed in USSR in 1983

**Lindane**
- Replaced DDT until banned in the 1990's
- Mobile in soils and can pollute groundwater
A Brief History of the Aral Sea Disaster

“The Great Game” – Colonial Conquest in Central Asia, 19th century
A Brief History of the Aral Sea Disaster

The Union Blockade, 1861

http://www.learnnc.org/lp/multimedia/12398
Soviet Agricultural Development

- The **USSR’s Five-Year Plans** led to rapid industrialization of agriculture and other sectors
- Cotton became a major focus of the USSR’s Central Asian economy

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“Be like Stakhanov!” ca. 1936  
“Grow vegetables!” ca. 1930  
“Women, adhere to cooperation!” ca. 1917  
“Our contribution to the world cause!” ca. 1951  

Joseph Stalin, 1941-1953
Soviet Agricultural Development

- **Kara-Kum Canal** [ca. 1954] – one of the largest irrigation canals in the world
- Supports agriculture in Turkmenistan, supplies water to the capital, Ashgabat
1991 - The Break-up of the Soviet Union
Vozrozhdeniye Island

- USSR Biological Weapons development site
- Stores of *anthrax, smallpox, bubonic plague*, and other diseases
- Abandoned in 1992
- 2002 international emergency project decontaminated the island

July - September, 1989  October 5, 2008
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The Loss of the Aral Sea

- Landscape and resource change
Diminishing Resources

- Rising salinity kills off most commercial fish
- Fishing villages decimated
- Fishing and canning industries abandoned
- Cultural loss of traditional foods and economy

Receding waters, ca. 1980
Biodiversity Loss

- **Caspian Tiger**
- **Saiga Antelope**
- **Kulan (Asian Ass)**
- **Bukhara Deer**
The Loss of the Aral Sea

- Landscape and resource change
- Migration issues
Migration out of Central Asia

The Loss of the Aral Sea

- Landscape and resource change
- Migration issues
- Health problems
Health Impacts

• As the sea dries up...
  – The sea bed is exposed to *aeolian* (wind) processes
  – Sediments are dispersed into the air
  – Along with these come *pollutants*, *toxins*, and *salt*, which are also present in the soil and water
Health Impacts

Dust storms

dust plumes

Aral Sea

eol.jsc.nasa.gov
Health Impacts

Dust storms
Health Impacts

- **Infants and Children are the most vulnerable**
  - Very high infant mortality rates
  - High incidences of respiratory illness in children

- **Adults suffer from:**
  - Respiratory illness, especially TB
  - Anemia
  - Kidney and liver diseases
  - Cancer
  - Lower life expectancy
  - Reproductive pathologies
    - infertility, miscarriages, complication in birth

*All of these have increased significantly in the last 20-40 years*
The Loss of the Aral Sea

• Landscape and resource change
• Migration issues
• Health problems
• Climate change
Climate Change

- **Sea Surface Temperature (SST) changes**
  - Previously, SST warmed the Siberian winds in winter, and cooled the region in the summer

- **Loss of the sea reduces SST effect**
  - As the sea looses volume, heat capacity is reduced
  - Warms up and cools off faster

→ Hotter summers, Colder winters
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The Aral Sea Disaster is a critical example of the environmental destruction wrought by humans

But human-environment interactions are complex!

Ecosystems are *dances* between biological species and the physical world, and they are continuously evolving and changing. We join in the dance, but we do not control it.
**Proximate cause** – immediate social or environmental factors that explain events

**Ultimate cause** – explanations that consider the larger context in which events take place; evolutionary forces
Why did the Aral Sea disappear?

Explanation #1: Human Perception and Response
The Aral Sea disaster is a “creeping” environmental problem

Problems slowly accrue over time

The rate of change is so slow that people don’t notice until it is too late
Like a frog in a pot....
Creeping vs. Sudden Disasters

Aral Sea

Chernobyl, Ukraine SSR, 1986
Creeping vs. Sudden Disasters

Aral Sea

Fukushima, Japan, 2011
Creeping Environmental Problems

Evolve slowly over time

Are hard to perceive, and therefore can go unnoticed for long periods of time

Result from the slow accumulation of human decisions over time

It is difficult to change the human systems that create the problem.

Food choices, agricultural strategies, infrastructure development, global trade, etc. all create the problem and perpetuate it.
Why did the Aral Sea disappear?

- Explanation #1: Human Perception and Response
- Explanation #2: Natural Processes
Natural Features of the Aral Sea

• **An *endorheic* basin**
  • internal drainage basin; “terminal” or “sink” lake
    = No outlet to the sea

• **Rivers deposit lots salts of sediments**

• **Very flat terrain**

• **Little rainfall**
Like water in a bathtub...
### Aral Sea Water Budget

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Lithology</th>
<th>Onset of salinity changes</th>
<th>Comments on the lake-level changes</th>
<th>Lake-level stands (m a.s.l.) (with relevant archaeological sites)</th>
<th>Age BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ±30 yrs</td>
<td>Low</td>
<td>Increasing</td>
<td>1960s: anthropogenic controlled lake-level lowering</td>
<td>Low</td>
<td>30</td>
</tr>
<tr>
<td>665 ±65 yrs</td>
<td>Low</td>
<td>Increasing</td>
<td>Little Ice Age: Climatically controlled lake-level lowering</td>
<td>Low</td>
<td>30 BP</td>
</tr>
<tr>
<td>1173 ±30 yrs</td>
<td>Low</td>
<td>Increasing</td>
<td>Mid Medieval: Climatically and irrigation controlled changes</td>
<td>Low</td>
<td>30 BP</td>
</tr>
<tr>
<td>1300 ±30 yrs</td>
<td>Low</td>
<td>Increasing</td>
<td>Early Medieval: Late Antiquity: Irrigation activities</td>
<td>Low</td>
<td>30 BP</td>
</tr>
<tr>
<td>1355 ±30 yrs</td>
<td>Low</td>
<td>Increasing</td>
<td>Late Antiquity: Climatically and irrigation controlled changes</td>
<td>Low</td>
<td>30 BP</td>
</tr>
<tr>
<td>1395 ±25 yrs</td>
<td>Low</td>
<td>Increasing</td>
<td>Classical Antiquity (?): Climatically and irrigation controlled lake-level lowering</td>
<td>Low</td>
<td>30 BP</td>
</tr>
<tr>
<td>approx. 2000 (?)</td>
<td>High</td>
<td>Increasing</td>
<td>Syr and Amu Darya Valleys: Excessive irrigation</td>
<td>Low</td>
<td>30 BP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kenderei and Polzhaj</td>
<td>Low</td>
<td>30 BP</td>
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<td></td>
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<td>?</td>
<td>Low</td>
<td>30 BP</td>
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<tr>
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<td></td>
<td></td>
<td>Pulzhaj</td>
<td>Low</td>
<td>30 BP</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Iron Age Priaralsk, Akespe</td>
<td>Low</td>
<td>30 BP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bronz Age Siberia Aral</td>
<td>Low</td>
<td>30 BP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lake level today (Zavidal, 2005)</td>
<td>Low</td>
<td>30 BP</td>
</tr>
</tbody>
</table>

Boroffka, et al. 2006:729
Antiquity
6th cen. B.C. – 3rd cen. A.D.
(Greeks and Romans)

Early Middle Ages
5th cen. A.D. – 8th cen. A.D.
(Dark Ages and Islam)
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Restoration in the North Aral
• Since 2007, the annual catch in the North Aral has doubled
• As of 2009, all of the fish species in the South Aral are dead
• Fisheries are working to bring back native populations of carp and sturgeon
Phytomelioration in the “Aralkum”

Planting of saxaul, tamarix, and *Calligonum* to stabilize dunes, shelter villages, and combat desertification

Seedlings of *Calligonum*, Aralkum floor

Black saxaul, planted in 2006
Archaeology and the Aral Sea

B.V. Andrianov, 1969
Archaeology and the Aral Sea
Archaeology and the Aral Sea

Cotton

Foxtail millet

Grape
Lessons from the Aral Sea

1. Humans can have significant impacts on the environment in relatively little time.

   We can cause climate change!
Lessons from the Aral Sea

2. Monocultures and industrial agriculture can have significant consequences. The USSR and the U.S. have followed similar paths.....
Lessons from the Aral Sea

3. History and geopolitics impact the landscapes we inhabit.
Lessons from the Aral Sea

4. Environmental change has consequences for human health, equity, and demographics. The changes we make to the environment change us.
Lessons from the Aral Sea

5. The interactions between human and natural systems are complex. Interactions are not always immediately perceptible and they are best understood in context.

Know your bioregion!