THE SHRINKING ARAL SEA:
An Ecological Disaster

case study | water resources unit

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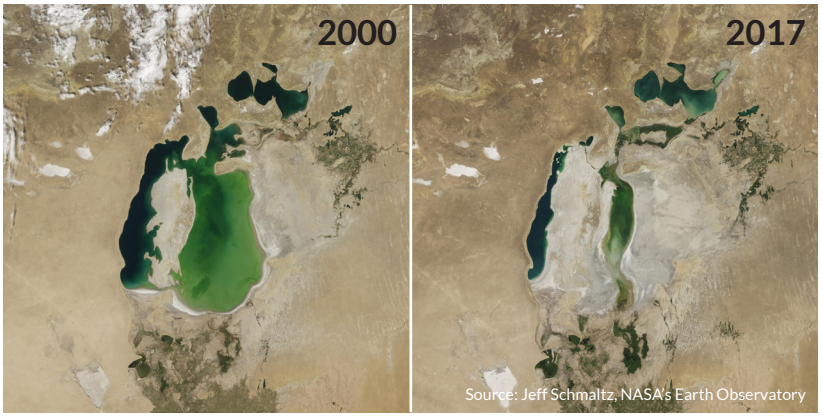
In the 1950s, the Soviet government conducted a secret biological weapons program on a small isolated island in the middle of the Aral Sea. A decade later, the sea began to dry up. The island grew. By the early 2000s, the Aral had shrunk to the point where the island was no longer an island, but was fully connected to the shore.[1]

Fearing the escape of weapons-strength pathogens, including anthrax and bubonic plague, the governments of the United States and Uzbekistan staged a mission in 2002 to destroy any dangerous remnants of the program.[2] This action may have prevented what had been an isolated threat from spreading far. But even without that legacy, the United Nations considers the shrinking of the Aral Sea the largest human-caused ecological disaster of the twentieth century. It demonstrates the far-reaching effects of growing human demands on scarce resources and serves as a reminder of the world's increasing interconnectivity.[3]

What happened to the Aral Sea?

The Aral Sea is located in Central Asia, on the present-day border of Kazakhstan and Uzbekistan. In 1960, it was the world's fourth largest inland lake. Its blue waters covered 26,000 square miles (67,500 square kilometers), an area greater than the state of West Virginia. Tourist resorts and busy fishing ports dotted its attractive shores. Now they are ghost towns in a desert, with no water in sight. Close to 90 percent of the lake's water is gone.[4]



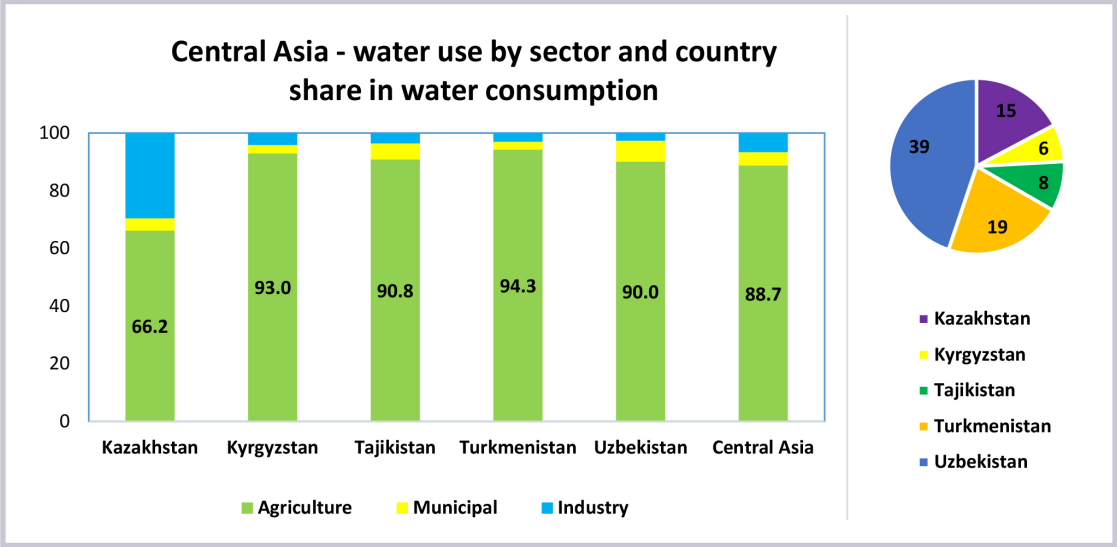
Satellite images show the drastic difference between the Aral Sea in 2000 and 2017.

What happened in between was a concerted effort to transform deserts into cotton fields. The Aral Sea's only sources of water are precipitation and river flow, primarily from the Amu Darya from the south and the Syr Darya from the north. Archaeological records indicate that people have used water from the Amu Darya (historically known as the Oxus River) for watering crops for at least 3,000 years. In the 13th century, when the Mongols invaded Central Asia, there was a major diversion of the river westward toward the Caspian Sea, but by the 1600s it was flowing back toward the Aral Sea. Farms, orchards, and herders used water from both the source rivers, but there was enough drainage flowing back into the basin to keep the Aral's water level stable for at least 300 years.[5]

Then in the 1960s, engineers developed vast water **irrigation** schemes to expand cotton production for the Soviet empire. Between 1965 and 1980, the region's irrigated area more than doubled. Fields were converted to cotton and new farms were plowed, until cotton accounted for 85 percent of the cropland. The growing water withdrawals from the Amu and Syr rivers to support the intensive agricultural production outpaced the drainage flows back to the rivers. The Amu Darya began running dry in some years and the Syr Darya flow was dramatically reduced. The Aral Sea was shrinking.[6]

The Aral Sea splits

In the late 1980s, the Aral Sea split into a "Small" Aral Sea fed by the Syr Darya and a "Large" Aral Sea fed by the Amu Darya. For several years, water flowed from the smaller to the larger body of water via a channel. Then in the 1990s, an earthen dike was built to control the flow and raise water levels in the Small Aral. After several breechings of the dike, the World Bank and the government of Kazakhstan supported the construction of an improved dike, which was completed in 2005. This project accounted for a quarter of the $85.8 million spent by the two entities on controlling water flows in the Aral Sea region.[7]



Source: FAO AQUASTAT

By 2009, just 10 percent of the 1960 water volume remained. The lake had divided further into four parts. In the north, the dike and dam that were finished in 2005 largely stabilized water levels in the Small Aral Sea. Fishing has been restored, though to a much smaller extent than before the split. The ecosystem shows signs of recovery. Water is occasionally released from the Small Aral into Lake Tshchebas, which formed between the Small and the Large Arals. The World Bank and the Kazakh government are continuing to work on rehabilitation.[8]

To the south, however, the Large Aral Sea, which lies almost completely in Uzbekistan, is mostly gone. It is divided into two lobes, its shape shrinking and growing as weather conditions and seasonal inflows change. For example, in 2010, the Amu Darya released a heavy flow and much of the Large Aral basin filled. But in 2014, it completely dried. In spring 2015 it partly filled again. Its size will likely continue to fluctuate in the future, but with the water four times saltier than the ocean, it cannot sustain fish.[9]

A heavy toll

When the Aral Sea was healthy, its productive commercial fishery supported tens of thousands of jobs. Populations in the region were growing quickly, at more than 3 percent annually in the 1950s, and the employment and food source were welcomed. But as the shoreline receded, those thriving towns watched the fish and the jobs disappear. **Groundwater** levels dropped, deserts spread, and thousands of people moved away in search of better lives. Rusting ships stranded dozens of miles from any water remind the remaining residents just how much their environment had changed.[10]

The city of Aralsk, Kazakhstan used to be located on the shores of the Aral Sea.

When the lake's water evaporated, it left behind salts and agricultural and industrial pollutants like heavy metals, organochlorine pesticides, and dioxins. Wind rushing over the exposed seabed blows the sand, salt, and pollutants, creating dust storms moving some 77 million tons of dust each year. The storms can cover as much as 2.5 million acres (100,000 square kilometers). The salt and chemicals they leave behind turn farms to wasteland. They also sicken people.[11]

Since the drying, health problems have increased. In some of the border towns, life expectancy fell from 64 years to 51. Rates of respiratory ailments, including childhood pneumonia and tuberculosis, are particularly high in the region. Anemia, birth defects, digestive illnesses, reproductive problems, and cancer rates are also elevated. Researchers associate these problems with the Aral Sea **desiccation** while noting that poverty, a loss of health care and social security, and high unemployment are also factors.[12]

Climate conundrum

Without the Aral's abundant water to moderate temperatures, summers are compressed: shorter and hotter. Winters are longer and colder. Rainfall is scarcer. These changes to the local climate have added extra hardship to living in the region.[13]

Considering climate more broadly, both rivers that feed the Aral basin originate in mountain ranges where ice and snow are melting at increasing rates as global temperatures rise. The Amu Darya is fed by glaciers and snowfields in the mountain ranges of the Pamirs and Hindu Kush. And the Syr Darya is fed by glaciers and snowfields in the Tien Shan Mountains. In the near term, accelerated melting means that river flows increase, with the potential to bring more water to the Aral Sea basin, if it is not siphoned off for irrigation before it arrives. But in a continually warming climate, as the snow and ice "reservoirs" shrink, the seasonal flow from melting will be reduced. This would be a large blow to agriculture.

Prospects for the future

Ultimately restoring parts of the Aral Sea requires reducing water withdrawals from the feeder rivers for irrigation. There are a number of tools in the water management toolkit to cut irrigation water use. At a basic level, water use efficiency involves making sure that more of the water that is diverted from rivers makes it to where it is needed. This entails reducing leaks and evaporation along with river channels. Flooding fields or furrows results in high water loss from evaporation, so switching to drip irrigation systems that deliver water right to plants' root zones can reduce losses.

Retiring fields and switching from thirsty cotton and rice to less water-intensive crops, are also part of the solution. Already, some land has been retired from cotton. In Uzbekistan, for instance, the cotton area has shrunk from 2 million hectares in 1988 to 1 million hectares in 2020. This is partly due to irrigation cutbacks and land contamination. The Uzbek government plans to restructure its agriculture sector and reduce cotton plantings in favor of other crops, particularly potatoes, but also other vegetables, fruits, and grains.[14] Considering that it can

take over 700 gallons of water to grow enough cotton for one T-shirt, moving away from such a thirsty crop in a water-stressed area makes sense.[15]

Cotton growing in Uzbekistan.

Whether such measures can help the Large Aral Sea is another question. Philip Micklin, who has studied water in the region since well before the breakup of the Soviet Union, estimates in a recent paper that it would take over a century to fill the Aral Sea basin to the 1960 level. He deems it highly unlikely to happen. He notes that some highly engineered schemes, such as a proposed diversion of Siberian rivers to increase the flow into the Aral, have been put on hold. They may never get under way because of the enormous cost and political difficulties, not to mention the risk of unforeseen consequences.[16] So for the foreseeable future, the Aral Sea as it used to be – a large blue gem in the middle of Central Asia – exists only on maps.

See this time-lapse video of the changing Aral Sea from NASA Earth Observatory:
https://youtu.be/UZwLTJroLpE

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