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# **Did the Desire for Cotton Self-Sufficiency Lead to the Aral Sea Environmental Disaster? A Case Study on Trade and the Environment**

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## **Introduction**

The desiccation of the Aral Sea was one of the greatest environmental disasters of the latter part of the 20<sup>th</sup> century. In 1960, it was the fourth largest lake in the world. However, since 1965, the sea has lost 75% of its volume and the coastline has advanced 100 kilometers. The sea is now divided into two sections and if desiccation continues, it will eventually devolve into a string of isolated salt lakes.

The desire of the former Soviet Union for self-sufficiency in cotton led to massive expansion of cotton production in Central Asia, mostly in Uzbekistan, and to the use of irrigated water from rivers that normally fed the Aral Sea. Could the environmental disaster have been avoided if the former Soviet Union had relied more on imported cotton and not diverted these rivers? Can we conclude that if the cost of the irrigated water had been properly considered, Uzbekistan did not have a comparative advantage in cotton production, and the Soviet Union should have imported the cotton? Or are other explanations more important in explaining the environmental disaster? We will consider these questions in this case study, but will begin with an elaboration of the environmental problems.

## **Environmental impact of the cotton production methods in Uzbekistan**

There is massive environmental damage associated with the method of cotton production in Uzbekistan. First, the obsession with growing cotton impeded the use of crop rotation (the basis for soil conservation). Balanced land use would have developed fodder crops and animal husbandry, which produce organic fertilizers necessary for soil fertility. Instead, large-scale and unbalanced application of mineral fertilizers and pesticides undermined the natural biological processes and degraded the soil quality. More than 30% of phosphorous-potash and more than 50% of nitrogen fertilizers cannot be absorbed by plants and form a runoff that pollutes the soil, rivers, and underground water. Second, because of low attention to land productivity, irrigated lands in Uzbekistan have shown a tendency to degrade. In the last two decades of the 20<sup>th</sup> century, saline land increased significantly to 52% of the total irrigated land area; of this saline land, 40% was rated as severe or moderately severe. Third, reduced flows of water from rivers and increased discharges of highly saline and polluted drainage water from irrigated areas (as well as from industry and communal sectors) have worsened the quality of water. In the 1960s the mineralization of water did not exceed 1.0 gram per liter. In 2000, it was 2-3 grams per liter in downstream river flows. However, use of water for irrigation with salinity of more than 1.0 gram per liter leads to a decline in crop yield. Fourth and foremost, the most dramatic ecological problem has been the desiccation of

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the Aral Sea. Extensive development of irrigation for cotton led to 90% of the decline in the runoff of water to the Aral Sea, and only about 10% of the runoff decline was associated with climatic variations. In addition to the facts mentioned above, since 1965 the sea level has decreased from 52.5 to 37 meters. It has lost 57% of surface, and more than 4 million hectares of sea bottom and river deltas have been exposed. The delta wetland areas, once covered by thick vegetation, are now covered by salt and sand. In addition, we have observed degradation of soil quality, changes in flora and fauna, a decline in the fishing industry, and a decrease in the efficiency of irrigated agriculture. Human health has also been adversely affected as both the supply and quality of drinking water have worsened. The natural climate around the Aral Sea has also changed and dust storms sweep across the areas around the Aral.

## **History of cotton production in Uzbekistan**

The main requirement for cotton production is warm to hot temperatures with low humidity and long hours of sunshine. Cotton needs about 180 very warm days to mature from its emergence from the ground to harvesting [1]. Areas with such characteristics inevitably have a dry climate with hot temperatures and low rainfall in the planting season. Parts of Central Asia, in particular Uzbekistan, had the correct combination of climate, soil and labor availability, and in the 19<sup>th</sup> century, given the amount of land devoted to cotton production, water was also available. When Russia gained control over Central Asia in the 19<sup>th</sup> century, Russian businessmen started growing cotton there using mainly American cotton seeds. In the late 19<sup>th</sup> and early 20<sup>th</sup> centuries, one-third of total irrigated lands were devoted to cotton production, with the rest devoted to grain, fruits and vegetables.

The government of the former Soviet Union pushed the self-sufficiency objective in cotton production much further than Tsarist Russia had done. Moreover, foreign exchange earnings from cotton were a desired objective. Cotton was declared “white gold”. Because of Uzbekistan’s arid climate, low rainfall and high evaporation, irrigation is an indispensable factor for cotton planting. A key decision of the Soviet planners was to massively expand the land devoted to irrigated cotton production in Uzbekistan. Irrigated lands in Uzbekistan increased from 1.2 million hectares in 1913 to 2.3 million hectares in 1950, and to 4.2 million hectares in 1990. Large public investments in irrigated lands facilitated this expansion [2].

After 1960, the land devoted to cotton production in Uzbekistan constituted about 61% of arable land. This level of specialization was found nowhere else in the world [3]. From 1930 to 1990, Uzbekistan was producing more than 2/3 of all cotton produced in the former Soviet Union. Uzbekistan was the world’s fifth largest cotton producer out of 90 cotton growing countries and the second largest exporter of cotton fiber after the U.S. [4; 5]

The expansion of irrigated lands has led to the massive withdrawal of more than 90% of water resources from two major Central Asian river basins – Amu-Darya and Syr-Darya - for irrigation of cotton and other crops. From 1913 to 1960, out of on average 120 billion cubic meters of water available every year from these rivers, about 64 billion cubic meters was used for irrigation purposes and the remaining 56 billion cubic meters flowed into the Aral Sea [6]. However, by the mid-1980s, the river inflow to the Aral Sea was reduced to just 2-5 billion cubic

meters per year [7], which is much less than the evaporation from the Aral Sea of about 40 billion cubic meters per year.

### **Could the environmental disaster have been avoided?**

One interpretation of the facts above is that Soviet planners failed to properly take into account the cost of irrigated water. An accurate evaluation of the cost of the water would have resulted in the conclusion that Uzbekistan was not an efficient place to produce cotton. Comparative advantage would have dictated a greater reliance on imports.

There are, however, other interpretations. Fundamental market-based reforms would have allowed greater cotton production on less land, thereby diverting less water. And it may have been possible to import water.

**Productivity Increases on Less Land.** From 1925 to 1928, the Soviet government conducted a land reform which distributed all irrigated lands to peasant family farms on the basis of a long-term and inheritable land lease. This led to the doubling of cotton yield in Uzbekistan in two years. However, in the 1930s Stalin forcefully transferred family lands to collective agricultural enterprises (*kolkhoz* and *sovkhos*). A family could no longer be the agent (unit) that held economic rights to land for farming. Lands that had been used for family farms were organized into collectives, with a large number of workers. A command and control system was implemented in which the government determined input and output volumes. Low farm gate prices well below international levels were offered. Poor incentives to farmers led to low efficiency in cotton production.

Serious market reforms that would create incentives for farmers on existing land, would have permitted an increase in cotton production without the expansion of land and greater use of water. It is possible, but difficult to conclude with certainty, that productivity increases would have saved enough water to avoid the environmental disaster. The Soviet communist party, however, wanted to avoid these kinds of fundamental market-based reforms.

**Imported water.** Soviet planners predicted that the planned massive expansion of irrigated land in Uzbekistan would cause the Aral Sea desiccation. To prevent that, in the 1960s Soviet scholars prepared feasibility studies on a project to divert about 27 billion cubic meters of water from the Siberian river Ob (6% of its total runoff) through a canal of 2550 kilometers. Estimates of the construction costs vary widely [7; 11], but one recent estimate of the construction costs of a canal to prevent desiccation of the Aral Sea (without irrigation systems for agriculture) is US\$12-15 billion in 2003. Despite several promises by the Soviet government, the project was never implemented, and all work on the project stopped in 1986 amid nationalistic and environmental objections from Russia. Since 2000, however, discussions between Russia and Uzbekistan regarding this project have been revived.

### **Conclusion**

Water resources in Central Asia were not properly valued in the Soviet system and this led to an environmental disaster in the Aral Sea and Central Asia. Fundamental market reforms

providing incentives to poor farmers would have increased productivity and achieved greater output without the need to divert as much water. It is difficult to conclude that this would have saved enough water to avoid the environmental problems of the Aral Sea, but these reforms were anathema to the Soviet system. Importing Siberian water would likely have avoided the disaster, but this was a very expensive project and it faced nationalistic obstacles in Russia. Given these constraints on sustainable cotton production in Central Asia, evaluation of costs that include the water resources costs, would imply that Central Asia lacks a comparative advantage in cotton production and should be importing more cotton.

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