The Ataturk Dam is the centerpiece of the Southeastern Anatolia Project, a massive public works program that extends across 9 provinces and includes the construction of 22 dams and a 1,800-km long hydro-electric system along the Tigris and Euphrates Rivers. The government of the Republic of Turkey has spent $32 billion on this project, which aims to increase domestic energy production, boost agricultural productivity, and resolve the economic imbalance in the southeastern provinces of Turkey.

Once the Ataturk Dam began operating in 1992, the man-made 48.7 km^3 reservoir provided a steady flow of water to irrigate hundreds of thousands of hectares of cropland in neighboring provinces, like Sanliurfa, via massive underground tunnels.

Typically, irrigated crops like cotton are more profitable for small farmers, many of whom began replacing their non-irrigated wheat fields with irrigated cash crops, all the result of a region facing an intensifying risk of food insecurity.

This project uses satellite imagery and Turkish Agricultural Census data to measure the impact that the Ataturk Dam has had on agricultural production in southeastern Turkey. Using the province of Sanliurfa as an example, these maps demonstrate how rapidly the landscape has changed over a relatively short period of time.

Ground Cover: Sanliurfa Province, Turkey

<table>
<thead>
<tr>
<th>Year</th>
<th>Water</th>
<th>Vegetative</th>
<th>Non-Vegetative</th>
<th>Non-Agricultural</th>
<th>Salt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>50</td>
<td>30</td>
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<td>0</td>
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<td>20</td>
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The significant change in ground cover over the eight-year span is immediately evident when comparing the maps. Since the map was updated, the proportionally large increase is best noticed in the loss of brown, non-vegetated cropland and the materialization of a large expansion of land in the southwestern province of the province. The most rectangular green patch is the Harman Plain and it is the primary area irrigated by the two Sanliurfa Tunnels that use gravity-flow to deliver water from Lake Reservoir. Only one of the tunnels had opened by 1998, so it is possible to imagine that the area would contain even more agricultural vegetation today.

The salt patches, visible in pink in Figure 1, are the result of the natural seasonal flood/drought cycle of the Euphrates River. The Euphrates River follows south along the northern border of the province and the Ataturk Dam is located just below the point where the water begins to accumulate. Half of Lake Ataturk is located in Sanliurfa, while the rest of the 813 m^3 reservoir extends northward into the province of Adiyaman.

Choosing Agriculture: How the Ataturk Dam Impacted Sanliurfa’s Agricultural Production

Background

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Methods

These maps were constructed from high-resolution imagery taken by the USGS LandSat 7 satellite. Images from comparable dates in September when cotton is nearing harvest in Turkey, were selected with the Global Visualization Viewer. The years 1998 and 1999 represent a relatively short passage of time before and after the opening of the Ataturk and the satellite captured high-quality photographs in September of these years.

LandSat 7 Thematic Mapper captures seven distinct wavelengths of visible and infrared light as they reflect off the earth’s surface. After compiling the different bands into a single raster image, two adjacent rasters from each time period were mosaicked together.

After resolving the assembled raster images to the border of the Sanliurfa province, it was apparent that several pixels were missing data. This slight deficiency was disregarded due to the limited scope of the project, and the excessive resources that would have been required to download and mosaic the missing segment of the LandSat imagery.

Next, each year’s derived raster underwent several experimental IsoClusters and Maximum-Likelihood Classifications. After much trial and error, the rasters were digitally organized into 25 classes according to similarities across the different bands.

The classifications were manually compared with the false-color RGB composites for accuracy and then painstakingly reclassified into five general categories.

Water: The Euphrates River, irrigation channels, reservoirs, etc.

Agricultural Vegetation: Green cereal crops ready to be harvested Non-Vegetative Cropland: Irrigated crops with yellow to brown features Non-Agricultural: Rock, mountain, buildings, savana, etc.

Salt: Accumulates as a result of the river’s natural flood/drought cycle.

The maps in Figure 1 represent a static picture of ground cover before and after the completion of the dam. To observe change over time, the 1998 map was reclassified again to a specific numerical system. The Faster Calculator multiplied the raw map with the 1998 map and created 25 new classifications, shown in the table to the right.

The final map (Figure 2) required another reclassification, grouping to gather the pixels that didn’t change between 1999 and 1998 and grouping them according to their “changed” status in 1998. Because each pixel measures 30m x 30m, the total area of each ‘class’ simply requires multiplying the quantity of pixels by 900 and then dividing by 1,000,000 to get a result in km^2.

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Comparative Analysis & Conclusions

This project’s objective was not simply to visualize the changing landscape, but also to quantify the impact. In the table above, the shaded boxes indicate land that was left unchanged by the construction of the dam. The remaining boxes, which total 56,996 km^2, reveal how 36% of Sanliurfa’s landscape changed in just eight years.

The total amount of agricultural land (vegetative and non-vegetative) decreased by 2.64%, but the boxes highlighted in red show a 2.12% of agricultural vegetation was added. As a result, vegetative agricultural land makes up a much higher proportion of the total agricultural land in 1998.

In short, less total land is being cultivated, but in September—when irrigated crops like cotton are ready for harvest—more of it is vegetative.

This result is corroborated by the results of the crop yield analysis in Figures 3 and 4, on the left. Figure 3 indicates that a very clear increase in cotton production occurred in provinces where the Southeastern Anatolia Project improved irrigation from the Tigris and Euphrates Rivers.

Similarly, cotton production decreased in most other provinces, signifying a geographic shift in the core of turkey’s cotton production.

The USDA Foreign Agricultural Service notes that the region experienced a 50% increase in land used for cotton production between 1994 and 2001. Over the same period, the southeastern province went from producing 25% of the country’s cotton to producing half of the country’s supply.

With a large rural population that relies on subsistence farming, almost every Turkish province grows wheat. Again, the southeastern provinces outstripped the growth of the rest of the country’s wheat production, but not to the same extent that it did with cotton.

Between 1995 and 1998, provinces in the southeast more than doubled their cotton production. Similarly, production grew by 12% in the provinces.

As explained previously, an area of ~83 km^2 in mining from the final rasterized data. As a result, the final data for Sanliurfa is partially incomplete.

The IsoCluster reclassification, though highly accurate for most of the province, misclassified a substantial number of pixels along the northeast border of the province. In 1990 and 1998 the non-vegetative cropland area appears to be mountainous and rocky in the false-color RGB photo.

It repeated the error in both maps, this should not have greatly impacted the data in the comparative analysis.

The process of reclasifying into the few general categories was somewhat subjective because the reclasification process was done manually.

The classification system also failed to distinguish between man-made impervious cover (urbanization) and ‘natural’ non-arable land (rock). The IsoCluster would likely be unable to distinguish the difference if the man-made structures were made out of material cut from the ‘natural’ non-arable terrain.

A more detailed analysis and larger project would benefit from a closer examination of the IsoCluster and an expansion of scale into neighboring provinces.

Figure 1.

Figure 2.

Figure 3.

Figure 4.