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CE 394K GIS in Water Resources

12/5/14

Introduction

The purpose of this project was to focus on the demographics of two lignite-producing regions, and to give a brief overview of the importance of water management for the Texas “mining” sector. The “mining” sector for water resources in Texas includes oil and gas production along with other natural resource extractions, such as lignite and in some cases lumber (TWDB). To begin with, I wanted to create a map illustrating the geology of Texas and the major aquifers in the state to emphasize the overlap between the lignite formation and water availability. It is important to understand that water is used primarily in coal mining for coal washing, dust suppression, and equipment maintenance.

The coal is mined in seams, with equipment that requires water to be continuously run through the equipment, such as a cutting blade. The water used in this process, reduces the potential for fire to become a concern. This water is typically recycled and used in the coal washing stage, where coal is ground to the particular size that can be manageable by the transportation equipment – either by conveyor belt directly to the power plant, or by truck or train. Additionally, in most mining activities, it is essential for dust to be suppressed for multiple reasons including visibility and health of workers. Coal dust is incredibly hazardous to those that come into contact with it, and can be damaging to the mining equipment as well. Lastly, there are other aspects of water use in coal mining, which can include revegetation in the reclamation process.

While examining the mining locations on a simple topographic base map with a watershed layer, it is quite interesting to see that the entire mining site fits within a single watershed. The two mining sites used in this study are located in Rusk and Webb Counties, which are two vastly different sites from a geographic standpoint to a water availability standpoint. Rusk County is in the East Texas Piney Woods, where Luminant operates the Martin Lake facility. Webb County is located on the border of Texas and Mexico, where Farco Mining operated the fully reclaimed Rachal Mine. Reclamation is required by the federal government's Surface Mining and Reclamation Act or SMCRA, and is enforced by the Texas Railroad Commission (RRC). This requires the mining operation to put forth a bond, ensuring the proper remediation take place post mining completion. Reclamation creates a new ecological environment, and can be responsible for improving water quality in most regions where it occurs.

After realizing that there would be little information to show any additional watershed relationships outside of reclamation, and a peaked interest in demographics, I wanted to explore the potential relationships between income and education in these apparent labor based economies.

Methodology

The initial methods began with an examination of the relationship between Texas Geology, groundwater availability, and watershed location. Each of the following maps were created in either ArcGIS online, or through the desktop version of ArcGIS. The base layer is a topographic map, with the added layers data from the United States Geological Survey, and the Texas Water Development Board. The following map was created to show the geology and aquifer information, illustrating the overlap between the soil or lignite and water resources.

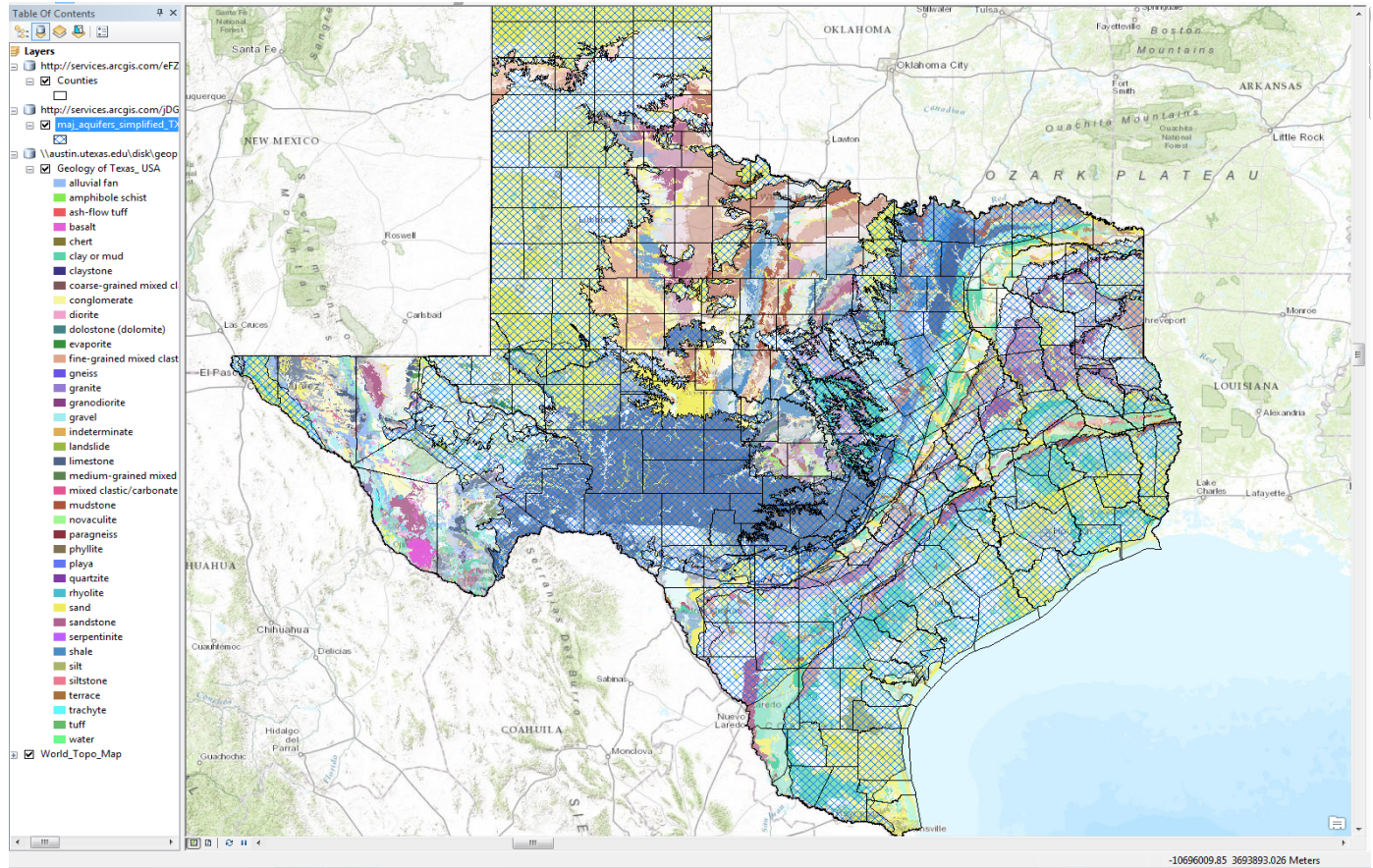


Figure 1, Texas Geological Formations and Major Aquifers

As seen above the layers in the southeastern portion of the map follow the lignite formation in the light purple colors and the overlay of the major aquifers on top with the cross hatching are almost directly on top of each other. Although water appears to be heavily available, one must consider the average rainfall and evaporation in the two regions in question. For this, the Texas Commission on Environmental Quality had a map that illustrated this perfectly, suggesting it to be unnecessary to create the same map again. This map can be seen below, with rainfall shown on the left and evaporation shown on the right.

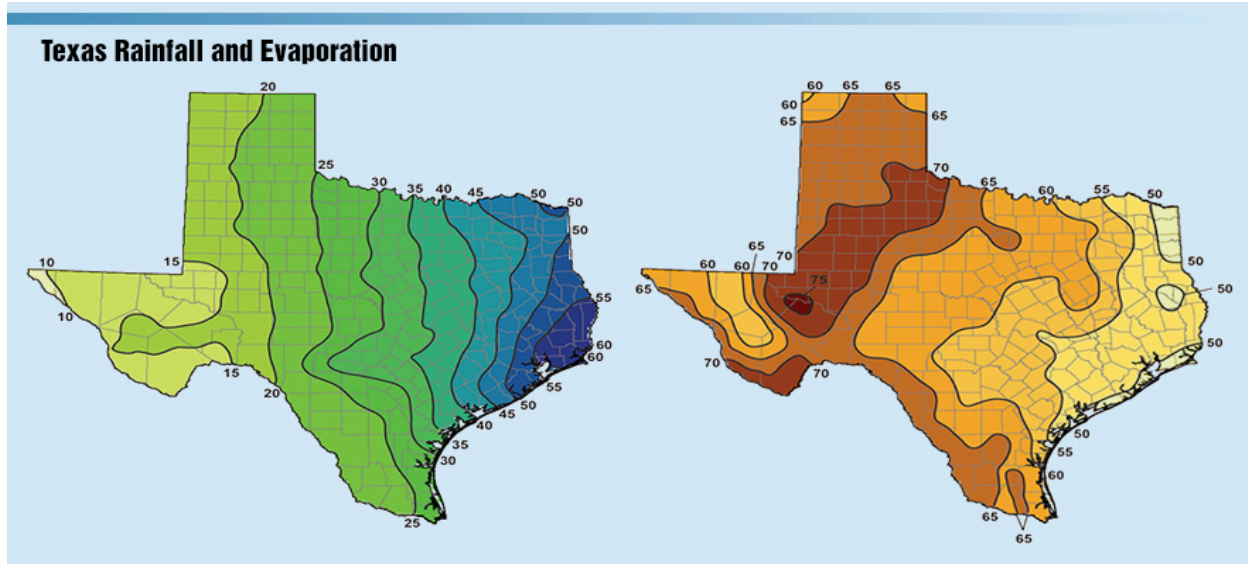


Figure 2, Courtesy of TCEQ

This map illustrates what the average rainfall reported in each county is. In Rusk County, the average rainfall is 45 inches per year with a smaller rate of evaporation. Rusk County also has a small portion of water-covered land, 15 square miles out of the 939 square miles. However, in Webb County, the average rainfall is only 20 inches per year with a very high rate of evaporation. The following maps were created using ArcGIS online with the topographic base map, and an overlay layer of watersheds and Texas counties. The first map shows Eastern Texas, with Rusk County highlighted by the coordinates of the Martin Lake mining operations shown. As seen the operations are on the edge of the county, but are all technically within the county line, and all within the Martin Lake watershed, as shown in the second map below. The next section of maps will also illustrate the same concepts in Webb County. The Rachal Mine coordinates are shown within the county, but notice the additional watersheds. In both cases, the entire mining property fits within one watershed. The potential of the reclamation and its impact on the watersheds were not determined, but could be an additional process considered if this project were further pursued.

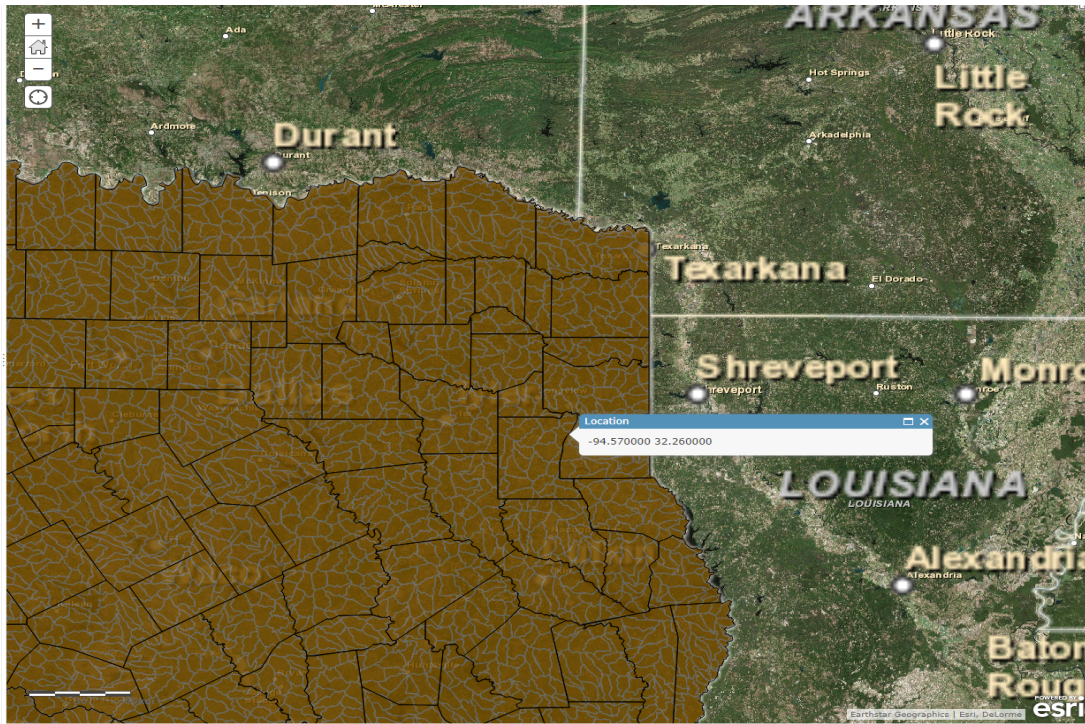


Figure 3.1, Rusk County Overview, Martin Lake Operations Coordinates

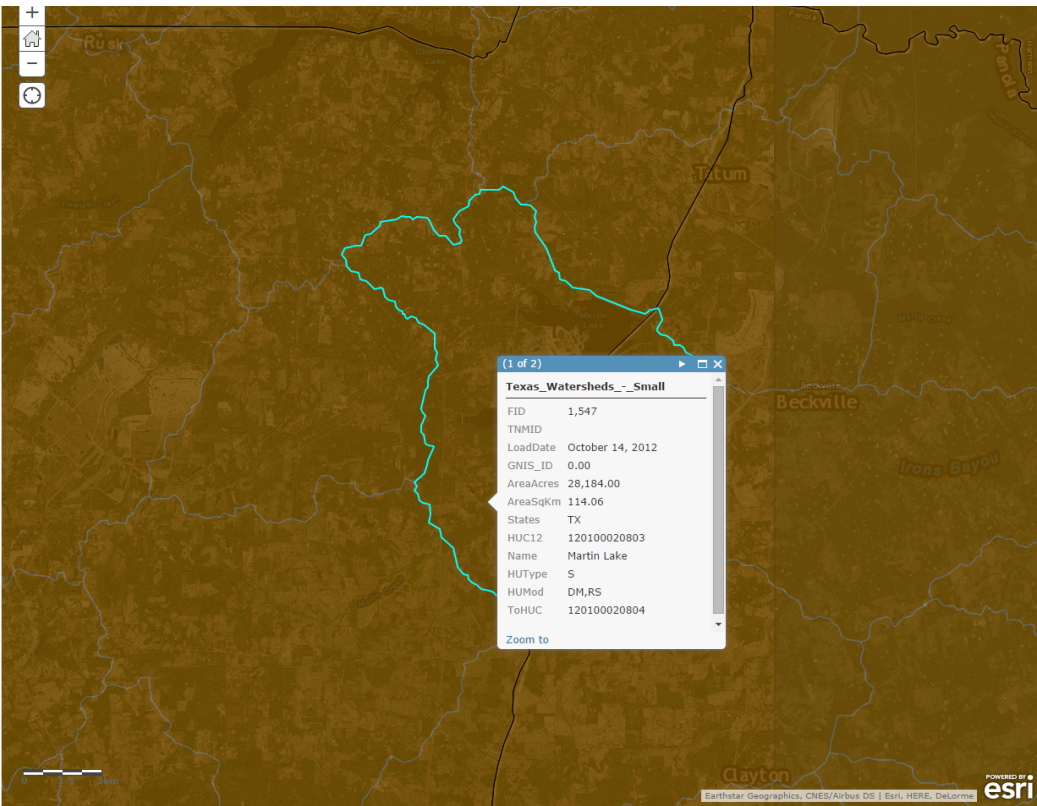


Figure 3.2, Rusk County, Martin Lake Watershed

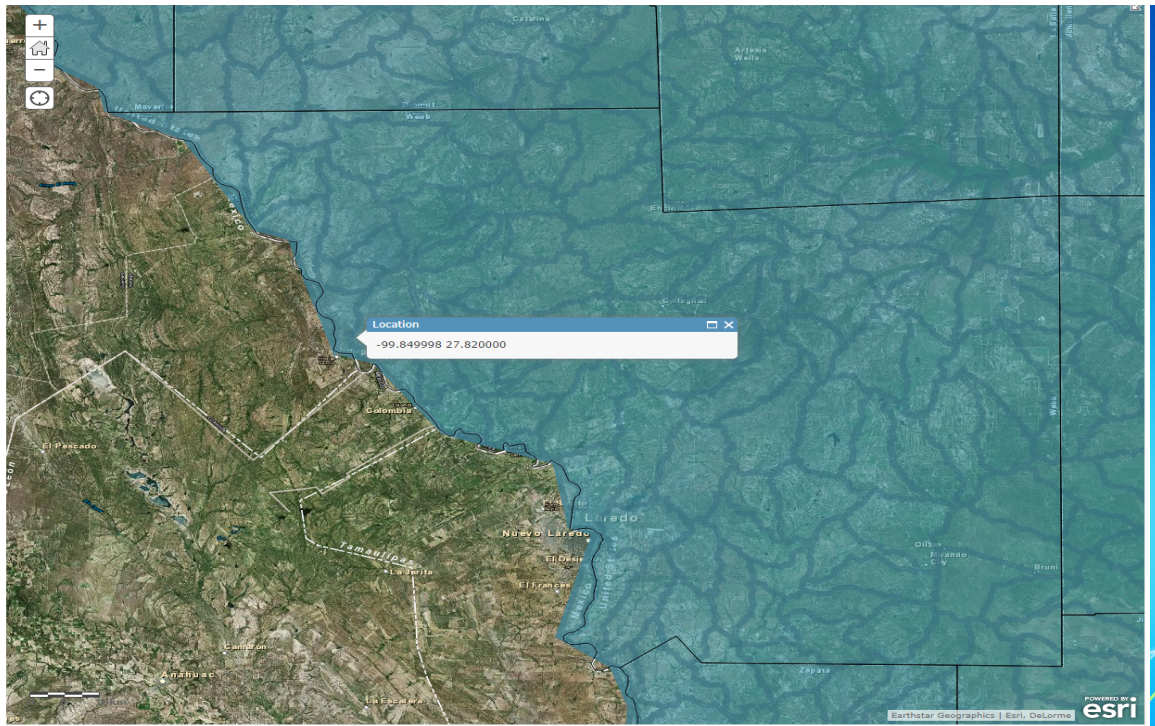


Figure 4.1, Webb County Overview, Rachal Mining Operation Coordinates

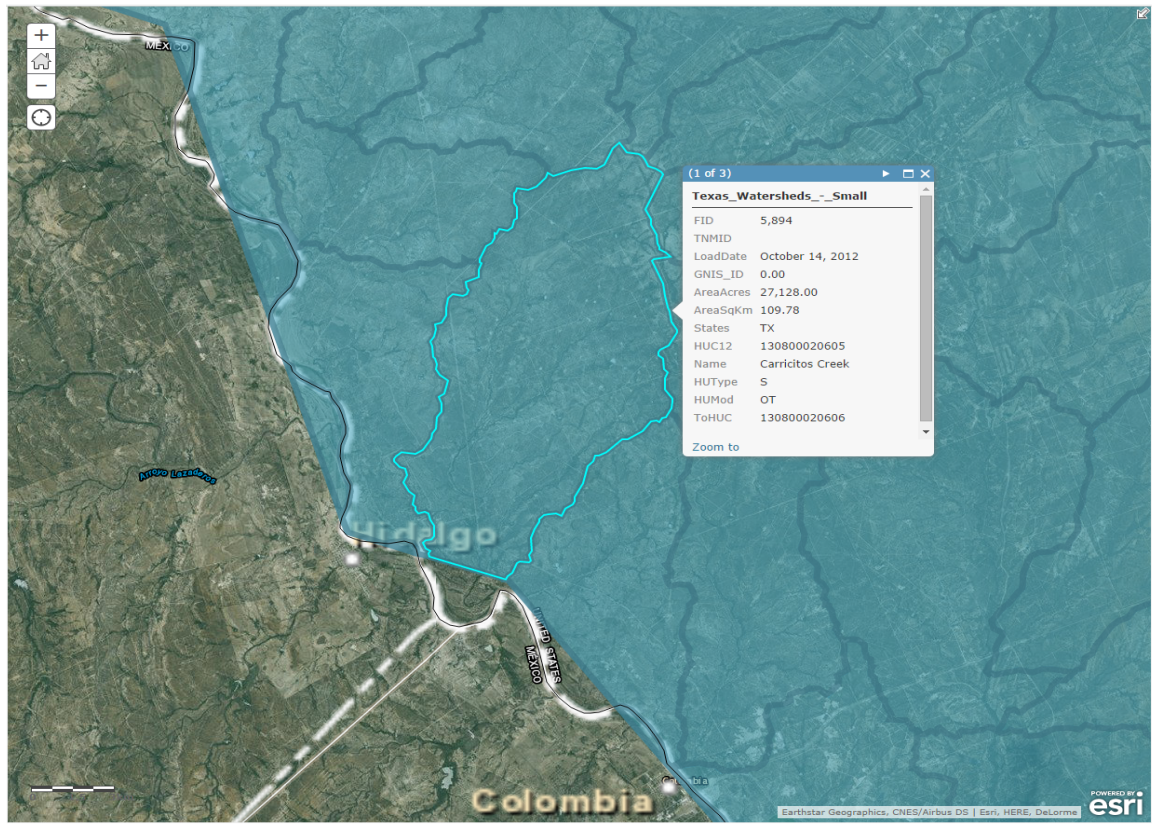


Figure 4.2, Carricitos Creek Watershed

The direction of the project changed after realizing that the entire watersheds encompassed the reclaimed land. The focus shifted to looking more at the demographics present within the counties, using the United States Census Bureau’s American FactFinder. Within this website, the Community Facts and the American Community Survey were used for data compilation. Information to compare the two counties data regarding employment status within the mining industry, race, total population, median household income, and educational status were analyzed. The results of population and race follow below beginning with Rusk County and preceded by Webb County.

Subject	Rusk County, Texas				
	Estimate	Margin of Error	Percent	Percent Margin of Error	
SEX AND AGE					
Total population	53,211	*****	53,211		(X)
Male	28,099	+/-69	52.8%		+/-0.1
Female	25,112	+/-69	47.2%		+/-0.1
Median age (years)	39.3	+/-0.4	(X)		(X)
18 years and over	40,861	+/-35	76.8%		+/-0.1
21 years and over	38,608	+/-203	72.6%		+/-0.4
62 years and over	9,368	+/-246	17.6%		+/-0.5
65 years and over	7,727	+/-99	14.5%		+/-0.2
Male	21,810	+/-74	53.4%		+/-0.2
Female	19,051	+/-63	46.6%		+/-0.2
65 years and over	7,727	+/-99	7,727		(X)
Male	3,409	+/-62	44.1%		+/-0.6
Female	4,318	+/-79	55.9%		+/-0.6
RACE					
Total population	53,211	*****	53,211		(X)
One race	52,591	+/-203	98.8%		+/-0.4
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White	42,018	+/-253	79.0%		+/-0.5
Black or African American	9,488	+/-169	17.8%		+/-0.3
American Indian and Alaska Native	192	+/-92	0.4%		+/-0.2
Asian	257	+/-37	0.5%		+/-0.1
Native Hawaiian and Other Pacific Islander	6	+/-10	0.0%		+/-0.1
Some other race	630	+/-228	1.2%		+/-0.4
HISPANIC OR LATINO AND RACE					
Total population	53,211	*****	53,211		(X)
Hispanic or Latino (of any race)	7,620	*****	14.3%		*****
Not Hispanic or Latino	45,591	*****	85.7%		*****

Source: U.S. Census Bureau, 2008-2012 American Community Survey

Explanation of Symbols:

- An '*' entry in the margin of error column indicates that either no sample observations or too few sample observations were available to compute a standard error and thus the margin of error. A statistical test is not appropriate.
- An '-' entry in the estimate column indicates that either no sample observations or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest interval or upper interval of an open-ended distribution.
- An '+' following a median estimate means the median falls in the lowest interval of an open-ended distribution.
- An '+' following a median estimate means the median falls in the upper interval of an open-ended distribution. A statistical test is not appropriate.
- An '*' entry in the margin of error column indicates that the estimate is controlled. A statistical test for sampling variability is not appropriate.
- An 'N' entry in the estimate and margin of error columns indicates that data for this geographic area cannot be displayed because the number of sample cases is too small.
- An '(X)' means that the estimate is not applicable or not available.

Figure 5.1, Rusk County Race and Population Statistics

Subject	Webb County, Texas			
	Estimate	Margin of Error	Percent	Percent Margin of Error
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
SEX AND AGE	<input checked="" type="checkbox"/>			
Total population	250,320	*****	250,320	(X)
Male	121,436	+/-135	48.5%	+/-0.1
Female	128,884	+/-135	51.5%	+/-0.1
Median age (years)	27.8	+/-0.2	(X)	(X)
18 years and over	162,462	*****	64.9%	*****
Male	76,787	+/-53	47.3%	+/-0.1
Female	85,675	+/-53	52.7%	+/-0.1
RACE	<input checked="" type="checkbox"/>			
Total population	250,320	*****	250,320	(X)
One race	248,442	+/-499	99.2%	+/-0.2
Two or more races	1,878	+/-499	0.8%	+/-0.2
One race	248,442	+/-499	99.2%	+/-0.2
Some other race	11,889	+/-1,398	4.7%	+/-0.6
Race alone or in combination with one or more other races	<input checked="" type="checkbox"/>			
Total population	250,320	*****	250,320	(X)
White	234,832	+/-1,431	93.8%	+/-0.6
Black or African American	939	+/-296	0.4%	+/-0.1
American Indian and Alaska Native	1,256	+/-617	0.5%	+/-0.2
Asian	2,096	+/-241	0.8%	+/-0.1
Native Hawaiian and Other Pacific Islander	25	+/-25	0.0%	+/-0.1
Some other race	13,093	+/-1,382	5.2%	+/-0.6
HISPANIC OR LATINO AND RACE	<input checked="" type="checkbox"/>			
Total population	250,320	*****	250,320	(X)
Hispanic or Latino (of any race)	239,295	*****	95.6%	*****
Not Hispanic or Latino	11,025	*****	4.4%	*****
Total housing units	73,548	+/-186	(X)	(X)

Source: U.S. Census Bureau, 2008-2012 American Community Survey

Explanation of Symbols:

An "****" entry in the margin of error column indicates that either no sample observations or too few sample observations were available to compute a standard error and thus the margin of error. A statistical test is not appropriate.
 An "-" entry in the estimate column indicates that either no sample observations or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest interval or upper interval of an open-ended distribution.
 An "-" following a median estimate means the median falls in the lowest interval of an open-ended distribution.
 An "+" following a median estimate means the median falls in the upper interval of an open-ended distribution.
 An "****" entry in the margin of error column indicates that the median falls in the lowest interval or upper interval of an open-ended distribution. A statistical test is not appropriate.

Figure 5.2, Webb County Race and Population Statistics

To summarize information found within the American Community Survey is shown below in the following table, comparing the two counties side by side. It should be noted that it appears that only a small portion of the county is educated, and a similar size of population works in a labor intensive natural resource field including agriculture, timber, mining, or within the oil and gas sector. Because of the similarities between these two counties, it seemed appropriate to see if there were any comparisons between net movement.

Rusk County		Webb County	
Total Population:	53,330	Total Population:	250,304
Educational Attainment:	80.1% H.S. <25 years 5% Bachelors Degree	Educational Attainment:	64.1% H.S. <25 years 4.3% >25 years 12.4% Bachelors Degree
Median Income:	\$46,220	Median Income:	\$38,421
Employment (>16yrs):	Total: 21,659 Labor Intensive: 2,368	Employment (>16yrs):	Total: 96,893 Labor Intensive: 2,479
Below Poverty Level:	15.3%	Below Poverty Level:	30.6%

Table 1, Comparison of Socioeconomics of Rusk and Webb Counties

To illustrate movement, as a way to explain why the socioeconomic factors and general demographics exist regarding race and population, the United States interactive Census Flows Mapper was used. Rusk County had very little movement in general, providing the following map of Net Movement shown below.

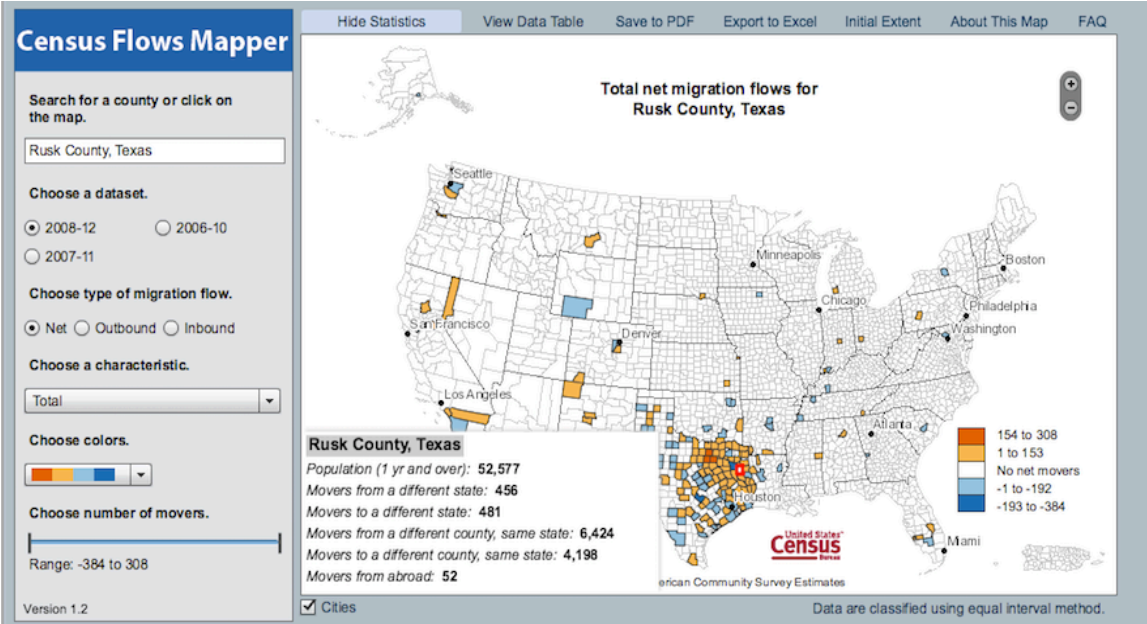


Figure 6.1, Rusk County Net Migration

Rusk County is a rural, East Texas community, which appears to have little movement and very few individuals working within the labor-intensive field as originally suspected. The low educational attainment statuses of the citizens indicates that most jobs within the county could be specialized, requiring little or no skill. Additionally, the low educational attainment status may be due to the proximity to a flagship education institution such as The University of Texas or Texas A&M, or their corresponding campus systems. The opposite can be said of Webb County, where Texas A&M International exists, as well as a higher educational attainment status also exists. However, the status is the same for a typical college aged individual, however, after 25 years of age the attainment status exponentially increases. This suggests that the individuals are reaching their educational status at a slower rate, which could be attributed to various reasons including socioeconomic status, race, or even movement. Webb County is home to Laredo, a border city with Mexico, and as shown below has interesting flows of movement, with a much higher international movement rate than that of Rusk County. Although it is higher, it is completely understandable that it may be due to the closeness of the region to another large Mexican border city.

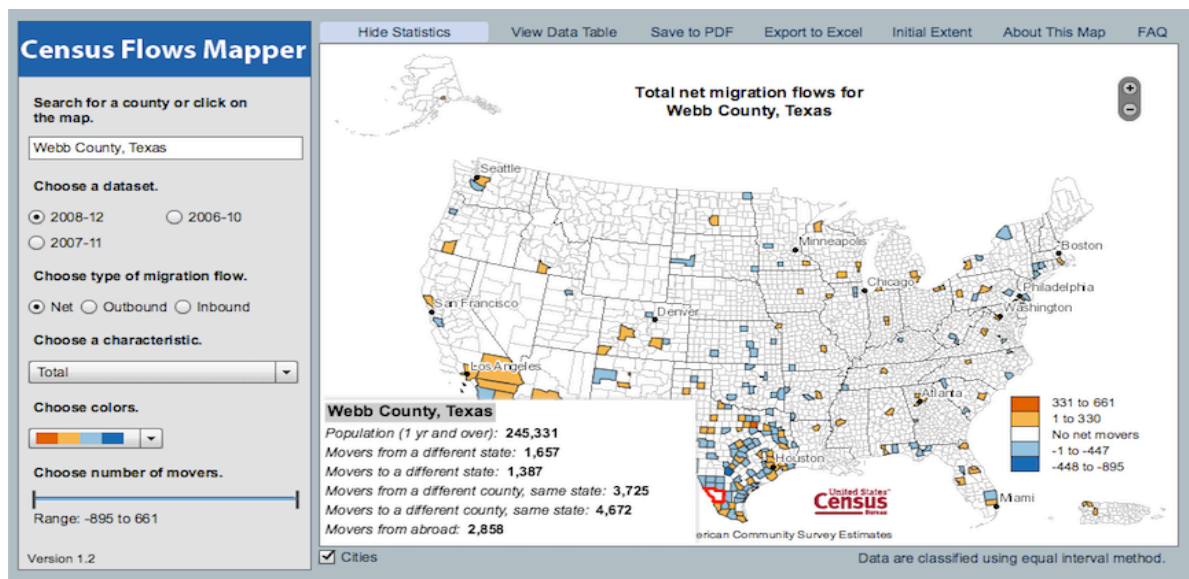


Figure 6.2, Webb County Net Migration

The separation of inbound and outbound is shown below, showing a greater inbound than outbound individuals in Webb County as compared to Rusk County, which is to be expected of a border city.

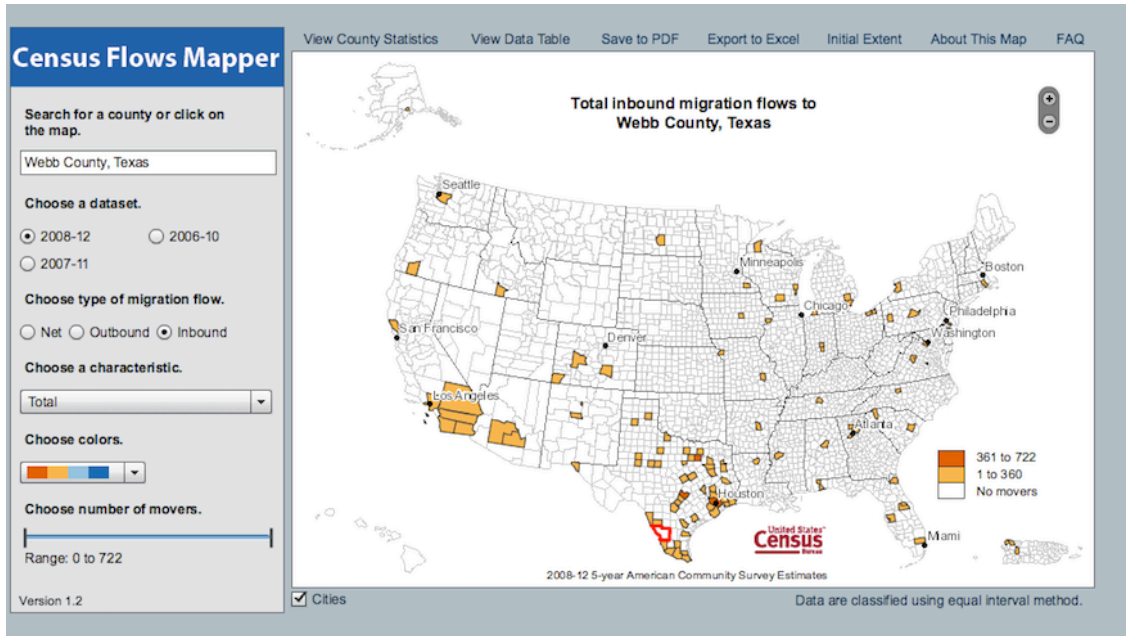


Figure 7.1 Webb County Inbound Migration Flows

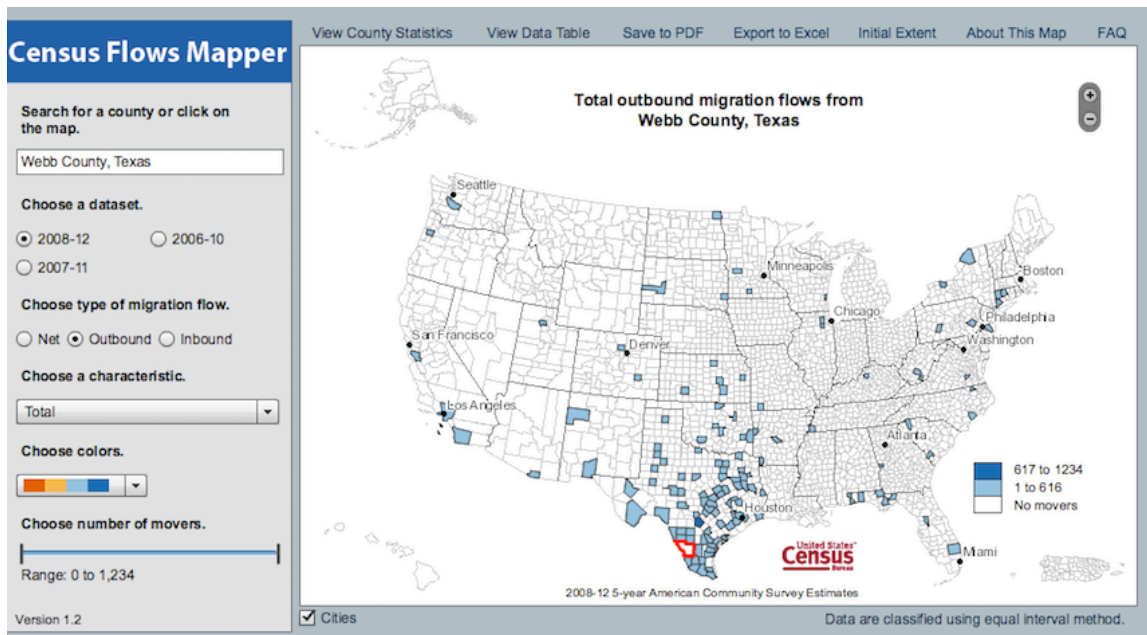


Figure 7.2 Webb County Outbound Migration Flows

Conclusion

Initially the purpose of this project was to evaluate lignite-mining operations on water use, water quality, and water availability. However, after quickly realizing the mining operations only impacted one watershed, and through reclamation may have actually contributed to an improved water quality through the created ecological system, analyzing the mining impacts seemed impractical. After changing the scope to focus on the socioeconomic factors of these two counties, the reasoning for labor-intensive jobs such as lignite mining or oil and gas was more logical. In counties where the median income is relatively low as well as the educational attainment level, labor-intensive or skilled professions are much more successful.

Lignite mining, the reclamation, and the maintenance of the reclaimed sites are successful in Rusk and Webb Counties for numerous reasons. However, policymakers and scientists need to ensure that water is available for all resources within the state, and particularly in regions where an unskilled labor market is dependent on jobs similar to lignite mining. Not only is water availability incredibly important, proper management of that resource should also be considered. If lignite is capable of producing water or improving water quality, there should be some sort of positive credit attributed to the operating company. This credit could be refocused and used in a similar employment opportunity as lignite mining. When considering lignite mining in general and the reclamation, there is potential to mimic the reclamation completed particularly in Rusk County, where Martin Lake State Park now exists, within the Martin Lake Watershed providing net benefits to the local environment.

Policy makers need to consider the impact of educational attainment and available jobs. Although higher education is ideal, an entire labor market is necessary, and should be protected and promoted by the local and state governments. To confirm the importance of this, one must

realize the opportunities within Rusk and Webb counties with the skill level of the potential workers. In Rusk County, there is little movement suggesting the maintenance of similar jobs is necessary, while in Webb County new job opportunities may succeed. However, to improve the socioeconomic status of all individuals, educational attainment levels could also be addressed. By improving or maintaining these opportunities and through proper management of the resources, an overall improved society could occur.

Resources

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