UTAH, WILL WE HAVE ENOUGH WATER?

An evaluation of domestic water use sustainability for HUC 8 size watersheds. Utah's population growth is increasing at a rate that may exceed available water resources. The scope of this report is to analyze available water resources and domestic water use, broken down by each HUC 8 watershed.

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Introduction

Utah is a popular place to live. There are many reasons why people like to live in Utah. From Alpine to Zions, from the salt flats to the world-renowned powder, Utah attracts many people and some choose to stay. Utah also has a stable and growing economy that continues to attract new and different types of businesses. Utah is also known for being a family friendly state and many people like to raise their families. Because of these and other qualities that attract people to live and stay in Utah, our population has been steadily growing, as shown in Figure 1. While a growing population can be beneficial to the economy and diversity of a state, it may tax the available water.

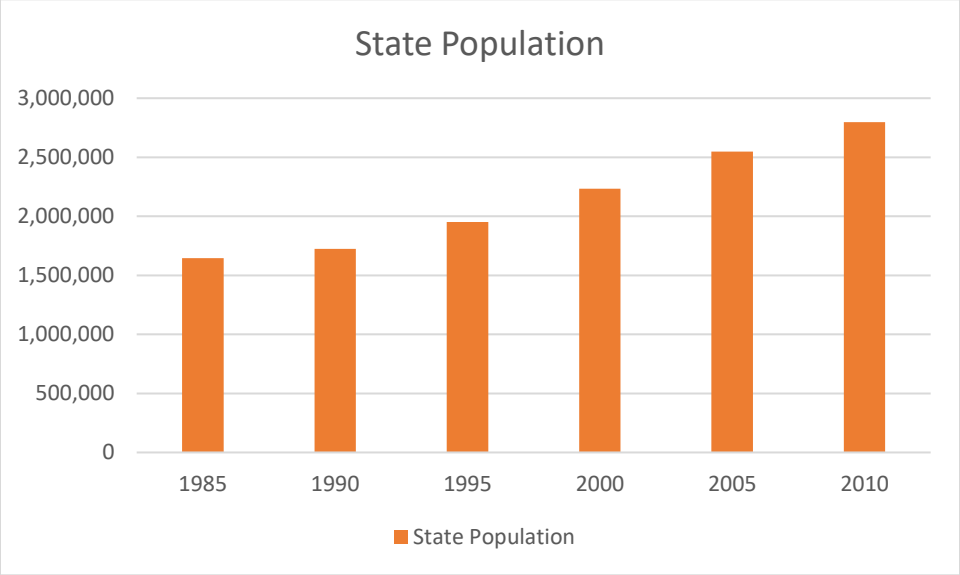

Figure 1 Utah's Population (Phipps)

The purpose of this report is to identify Hydrologic Unit Code (HUC) 8 areas, Figure 2, where domestic water use is above the watershed's ability to sustain the projected population. HUC 8 sized areas were chosen to better pinpoint areas of focus for water conservation efforts. The rest of the report will discuss the methodology used to calculate and map the population growth per HUC 8 area, water volume available to each watershed, the water use in each watershed, and the leftover balance of available water. This report discussed potable water use and therefore is not comprehensive and does not include analysis on groundwater or stream flow. Further recommendations to expand this project will be discussed in the conclusion and recommendation sections.

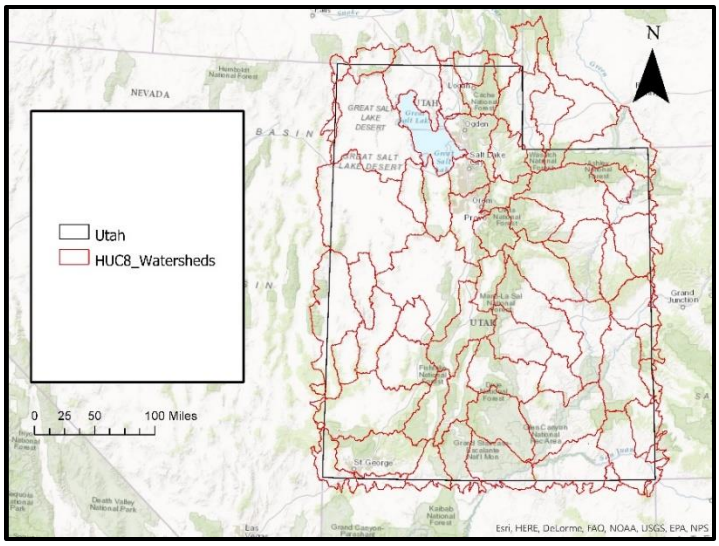

Figure 2 HUC 8 Watersheds in Utah

Methodology

Population

The Governor's Office of Management and Budget, in 2013, published population growth data for major cities and all counties in the form of an Excel file. Population growth projections are based on the 2010 census. As seen in Figure 3, Utah's population is expected to almost double by 2060.

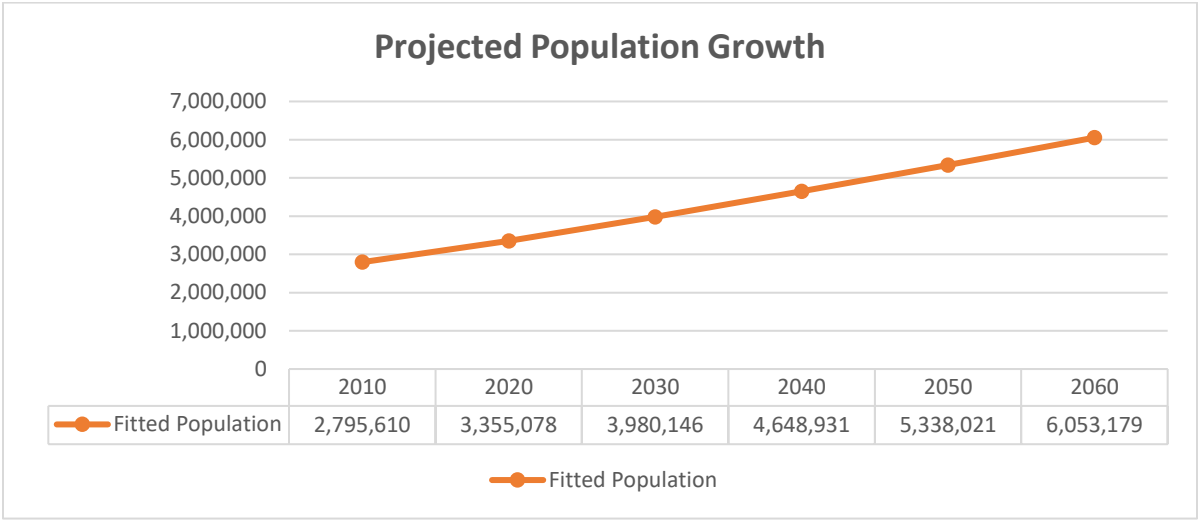

Figure 3 Projected Population Growth

The data from the Excel file was joined with a geodatabase file that included state, county, and municipal boundaries (State of Utah). There was a line of data for each county, which included the population that lived in each county, but not in an organized city. This data was joined to the county and was called the "County Balance" population. Then a spatial join was performed to assign the city population to the HUC 8 watershed area, see Figure 4. The join's parameter was set so that the geographic center of a city's boundary was the determining factor for which HUC 8 area the city and subsequent population were assigned to. For the rest of the population that lived outside city boundaries, County Balance population, an area ratio method was used by dividing the watershed area over the county area, then multiplying the ratio by the County Balance population.

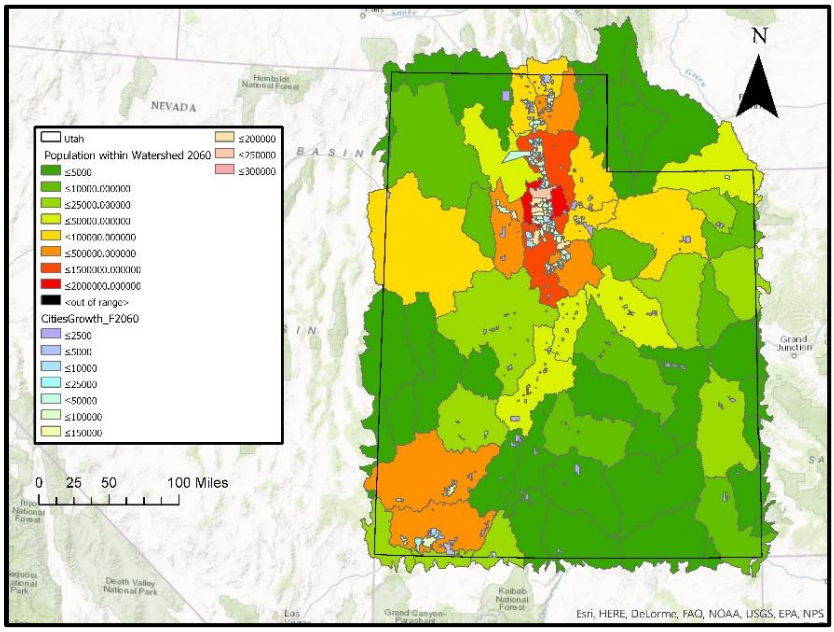

Figure 4 City Boundaries

After the calculations were done, a comparison was performed to check accuracy of the fitted data. Table 1 shows a max difference of about 28,000 people in 2060, about a .5% error, which was determined to be within a reasonable tolerance. The difference is most likely due to some watersheds extending beyond state boundaries, which affect the area ratio method.

Table 1 Population Comparison

Year	Population from GOMB	Fitted Population	Difference	% Error
2010	2,798,249	2,795,610	2,639	0.09%
2020	3,358,842	3,355,078	3,763	0.11%
2030	3,987,193	3,980,146	7,046	0.18%
2040	4,658,311	4,648,931	9,379	0.20%
2050	5,357,469	5,338,021	19,448	0.36%
2060	6,080,978	6,053,179	27,798	0.46%

For ease of visualization and for finding watersheds where high population occurs, ARCGIS Pro, geographical information system software, was used to map the HUC 8 watersheds and their

corresponding populations. Figures 5-10 show the population growth for each watershed. In the Salt Lake, Weber, Utah, and Morgan counties the population is high for years 2050 and 2060.

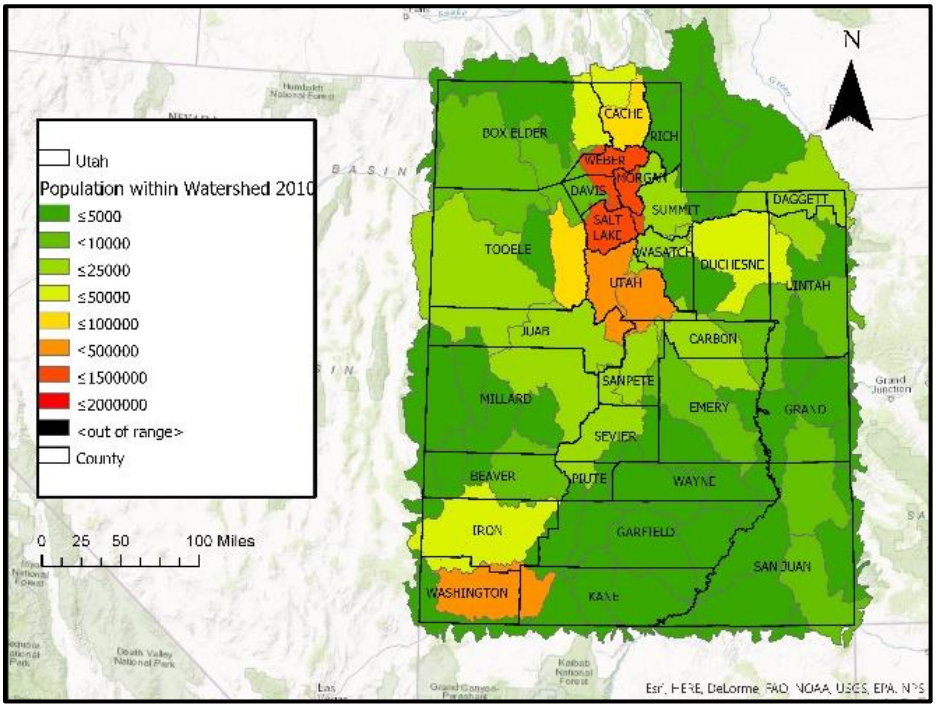

Figure 5 Population 2010

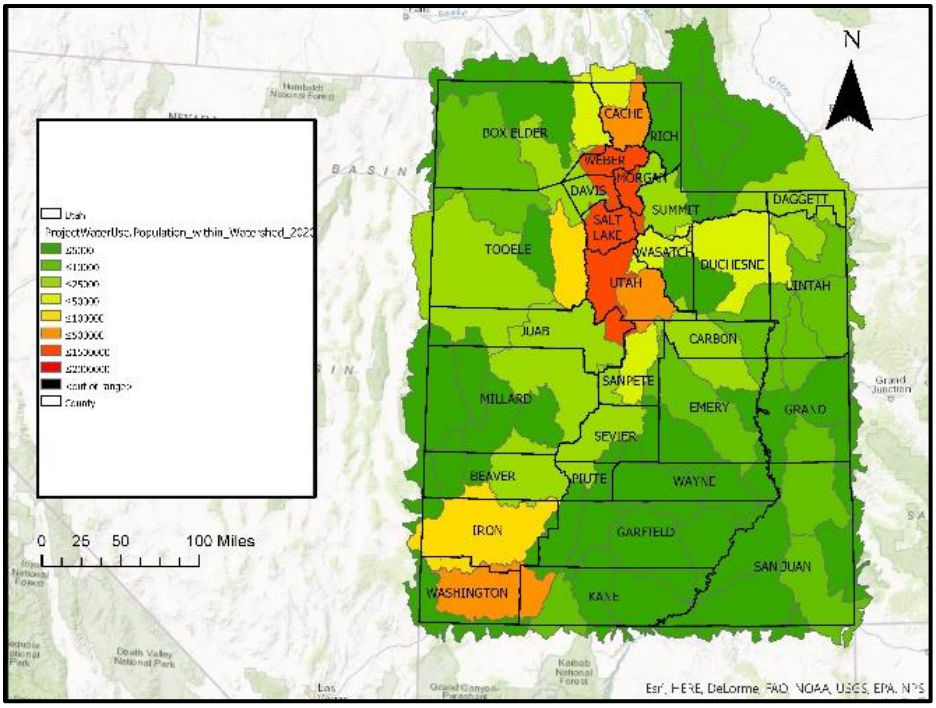

Figure 6 Population 2020

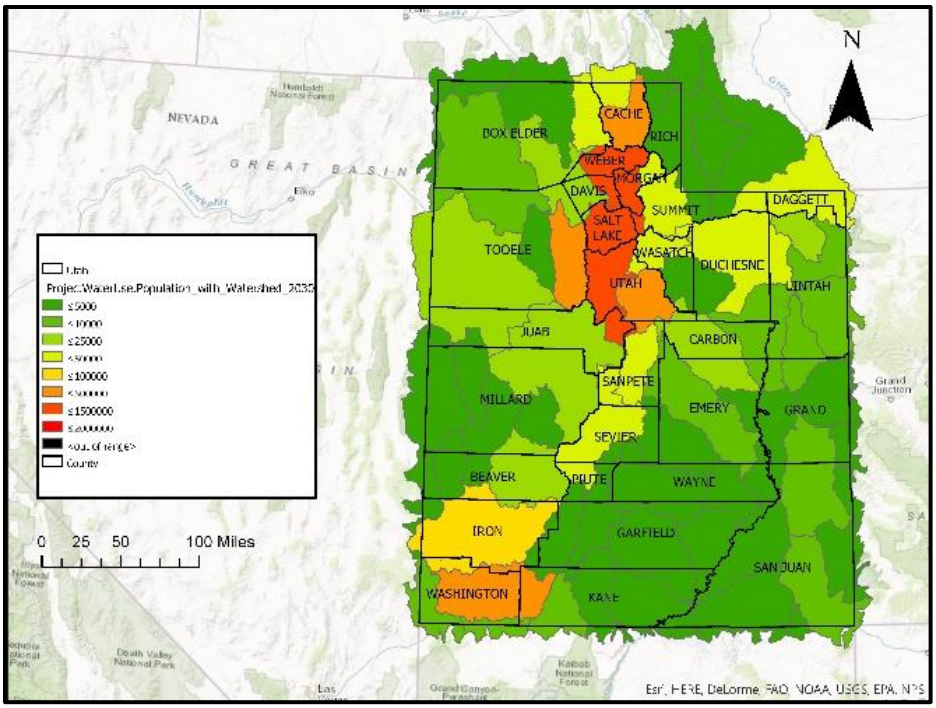

Figure 7 Population 2030

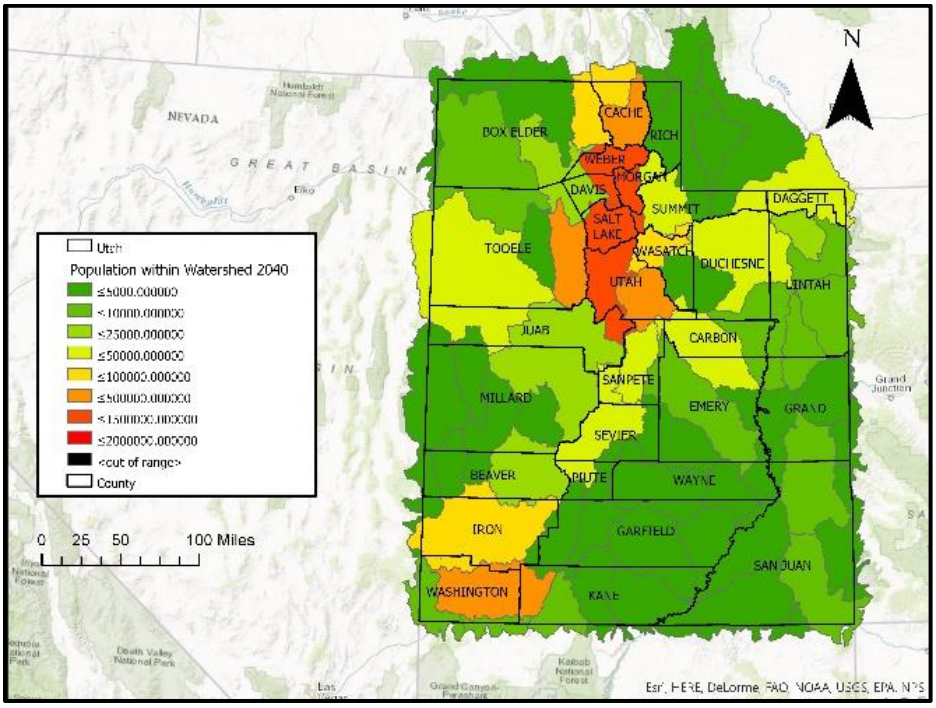

Figure 8 Population 2040

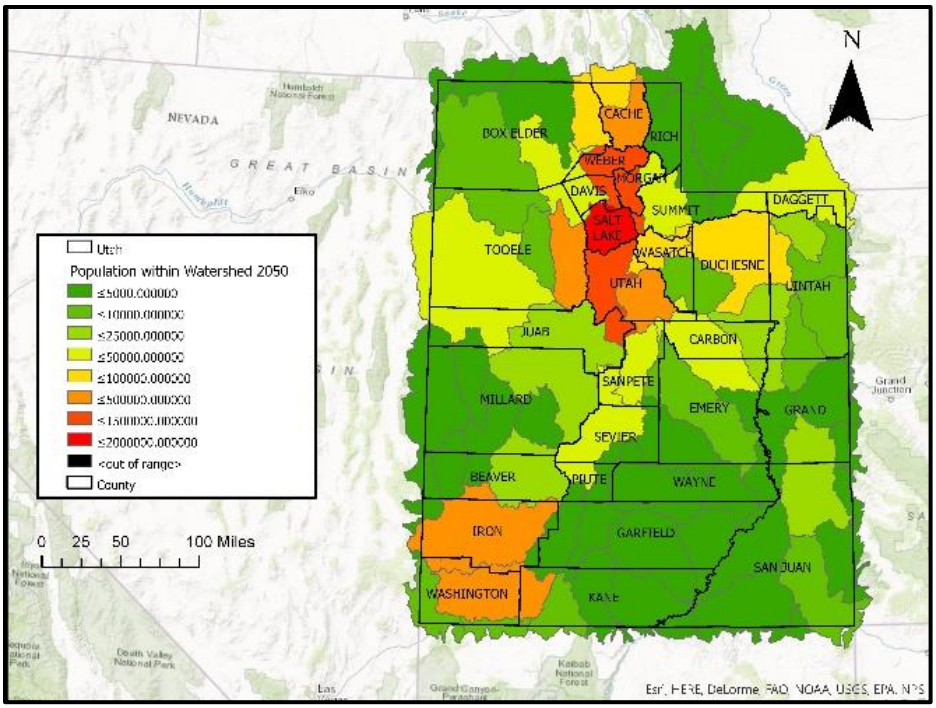

Figure 9 Population 2050

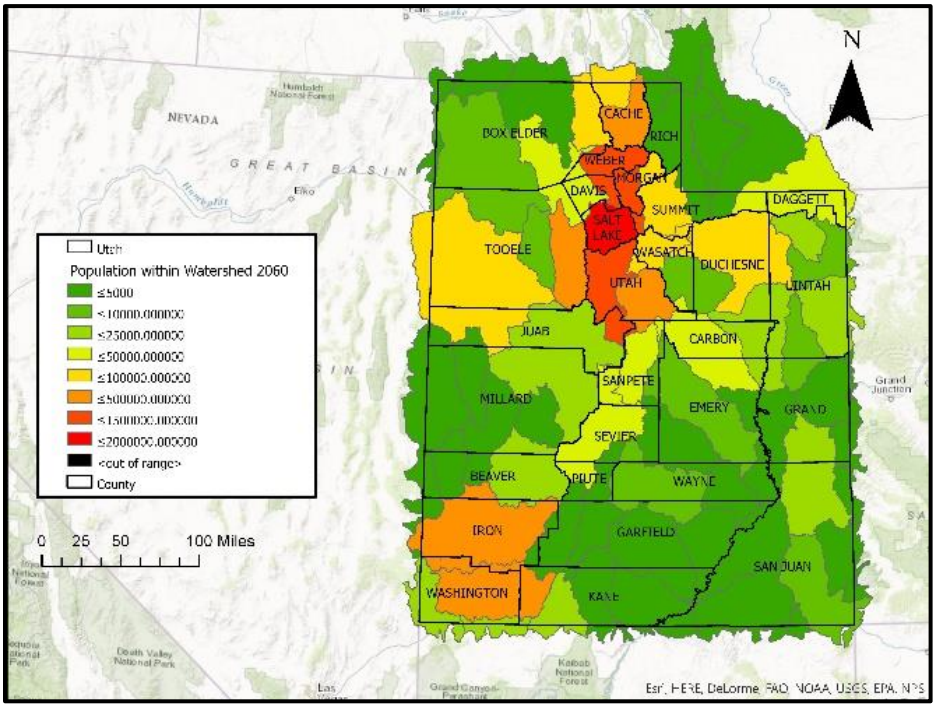

Figure 10 Population 2060

Precipitation

To find the amount of water available for each watershed, 30-year normal precipitation data was gathered from the Utah Climate Center (Utah Climate Center USU). The Thiessen Polygon method was used to calculate the average precipitation for each watershed. To double check this method, an average was taken of all the areas and their respective rainfall. Then a statewide average precipitation was calculated to be about 13 inches, which is consistent with reported data.

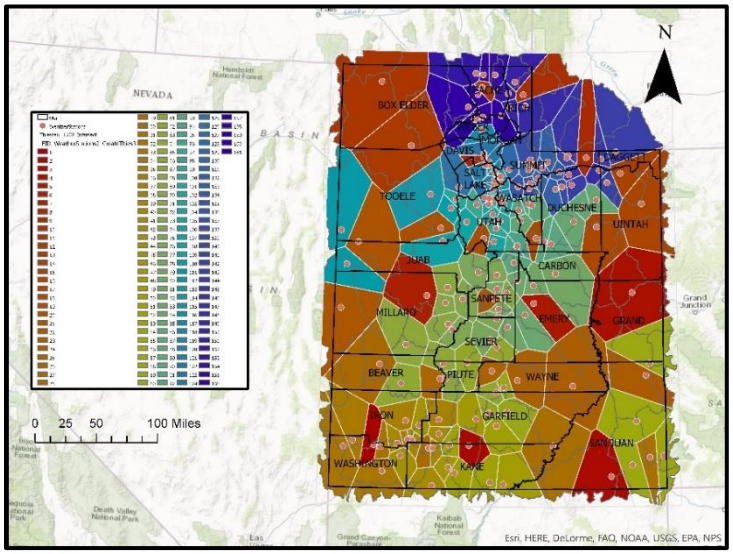

Figure 11 Thiessen Polygon Method

Then the water volume available per year was calculated by taking the average rainfall and multiplying by the area of each HUC 8 watershed, which was converted to acre-feet, see Figure 12.

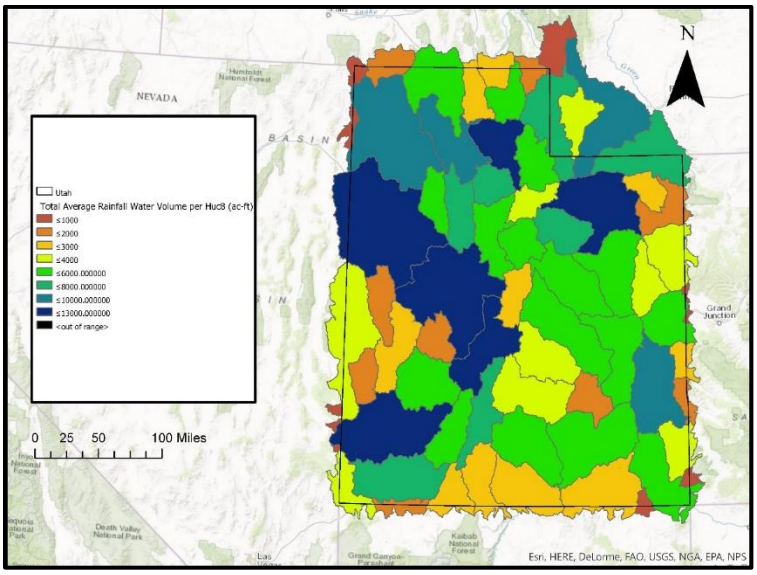

Figure 12 Water available in each watershed

Domestic Water Use

Water use data was obtained from the USGS National Water Information System (United States Goelogical Survey). The data was presented in an Excel file. The data contained information for domestic, industrial, agricultural, hydroelectric, and other water uses. For the purposes of this report, only domestic water use was considered in the analysis. Due to the complexity of tracking industrial, agricultural, and commercial water use, they were left out. For example, it would be hard to know if water for agricultural use came from a culinary water source, if it was used for livestock or crops, and how much of it went back into the ground or surface water after use. These items will be further discussed in the recommendation section.

The domestic water use, by county, was pulled out of two columns of data, Domestic use from Public-Supplied and Domestic use from Self-Supplied. Essentially the water source of these two is either the water coming from the city or water coming from a private well. An average of per capita water use was taken from both the public-supplied and self-supplied for all years of data to provide a conservative estimate. A visual is provided for easy comparison between counties, see Figure13, with the averages shown in Table 2.

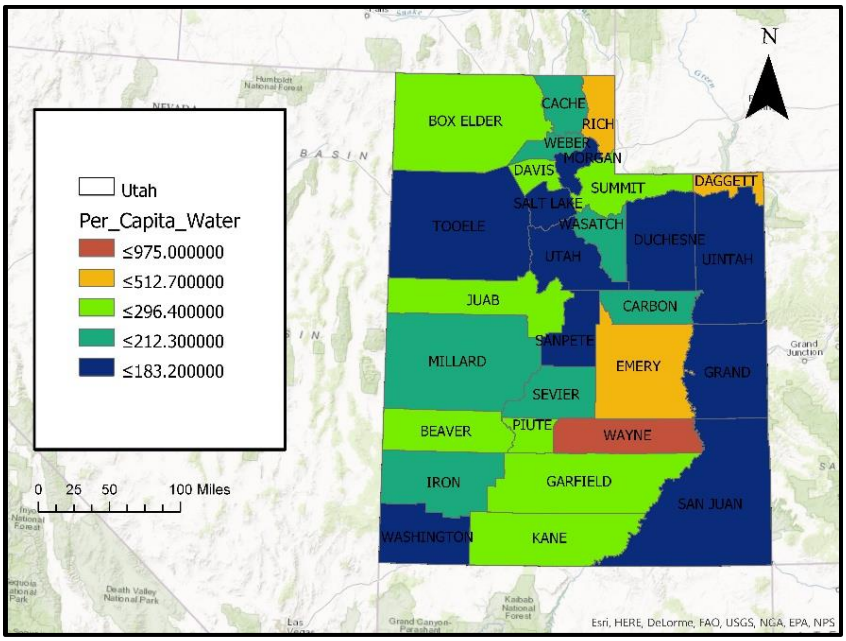

Figure 13 Per Capita Water Use by County

Table 2 Per Capita Water Use-by County

County	Average per capita use (gal/person/day)
Beaver County	230.4
Box Elder County	224.4
Cache County	204.5
Carbon County	202.1
Daggett County	384.5
Davis County	232.0
Duchesne County	151.7
Emery County	376.8
Garfield County	274.1
Grand County	173.6
Iron County	189.3
Juab County	239.4
Kane County	225.2
Millard County	212.3
Morgan County	169.2
Piute County	296.4
Rich County	512.7
Salt Lake County	151.3
San Juan County	183.2
Sanpete County	179.3
Sevier County	187.5
Summit County	254.1
Tooele County	166.9
Uintah County	171.2
Utah County	178.6
Wasatch County	194.8
Washington County	175.7
Wayne County	975.0
Weber County	199.1

Will we Have Enough Water?

Using the per capita data and multiplying by the population for each projected year, the total water use was calculated for each watershed. This was then subtracted from the available water to find the difference. The results show that Utah has an overall negative trend, where Utahn's are using more water that what is available from precipitation, see Figure 14. Figures 15 through 20 show the watersheds and their available water after domestic water use. Key watersheds to pay attention to are located along the Wasatch Front.

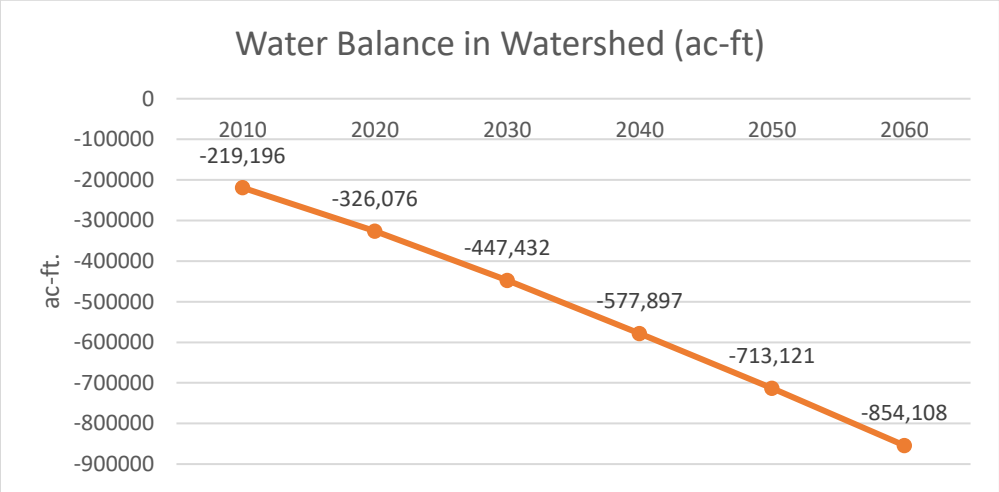

Figure 14 Water Balance

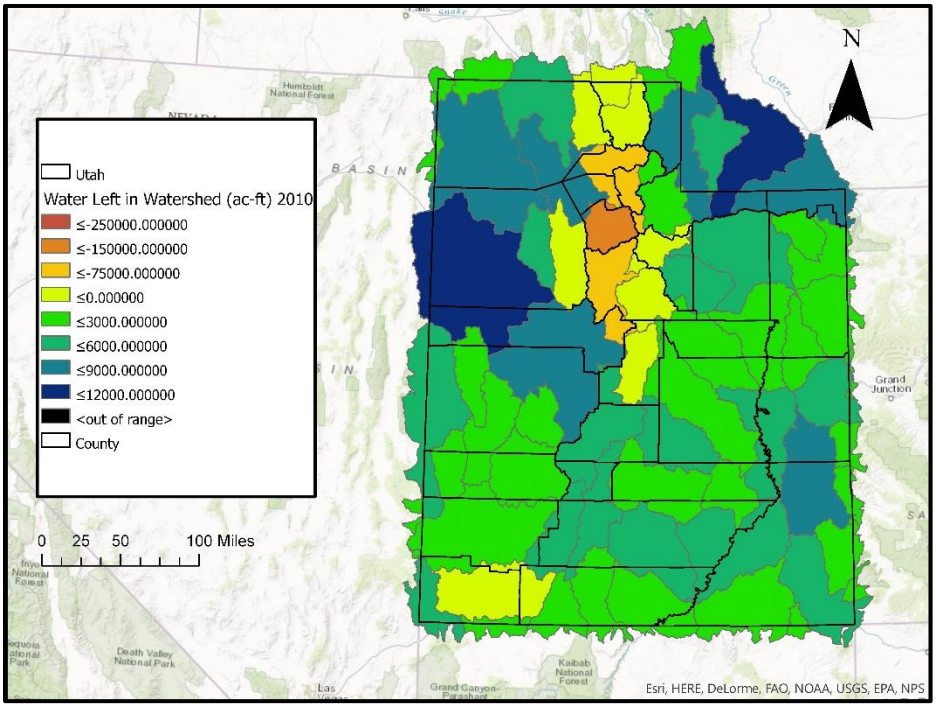

Figure 15 Water Available in Watershed After use 2010

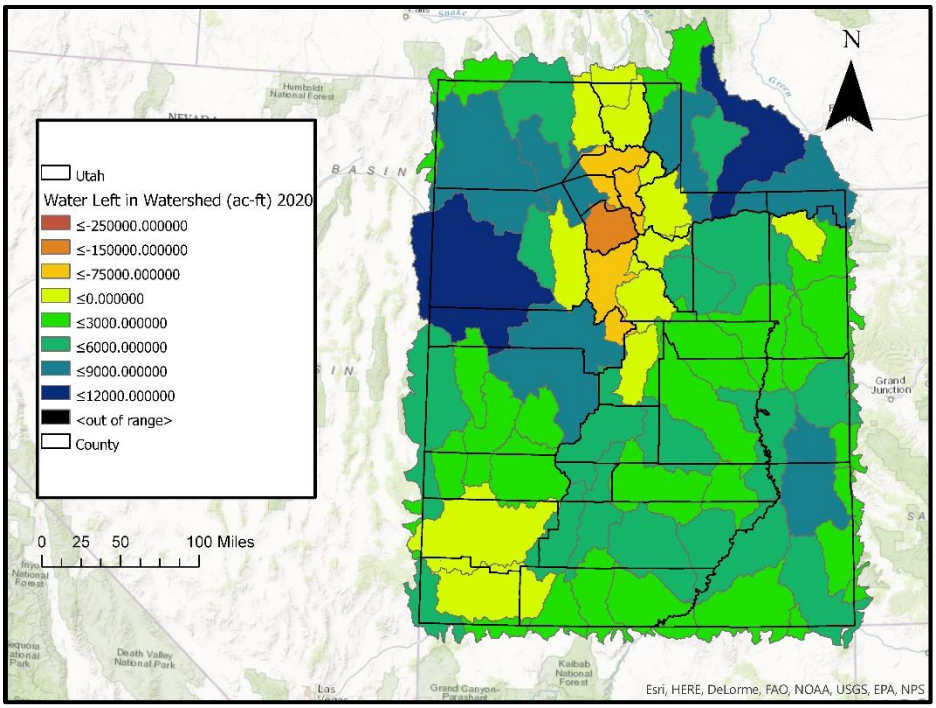

Figure 16 Water Available in Watershed After use 2020

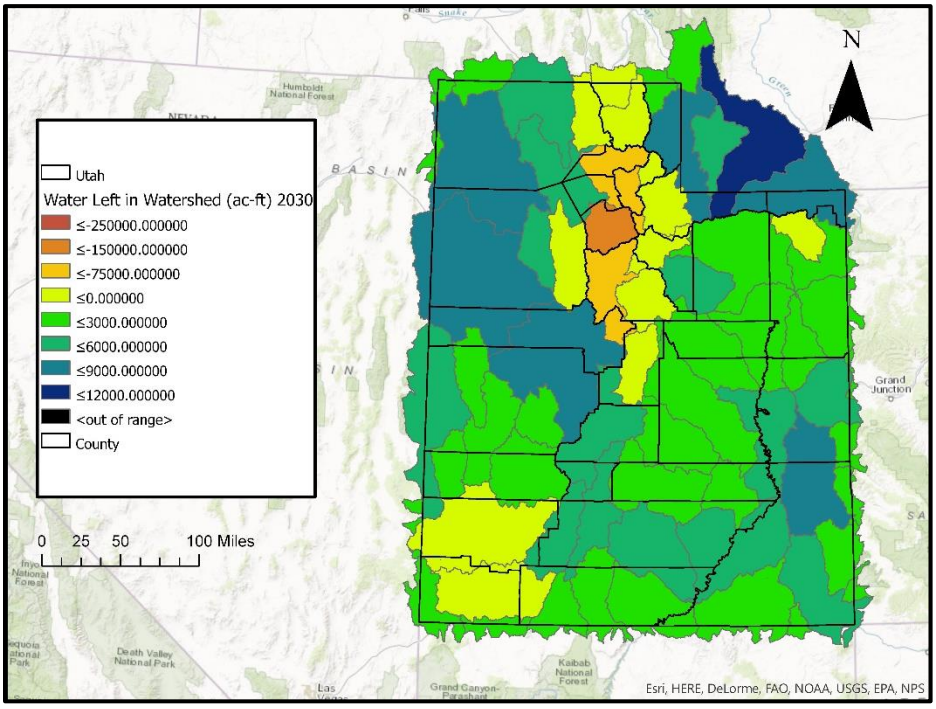

Figure 17 Water Available in Watershed After use 2030

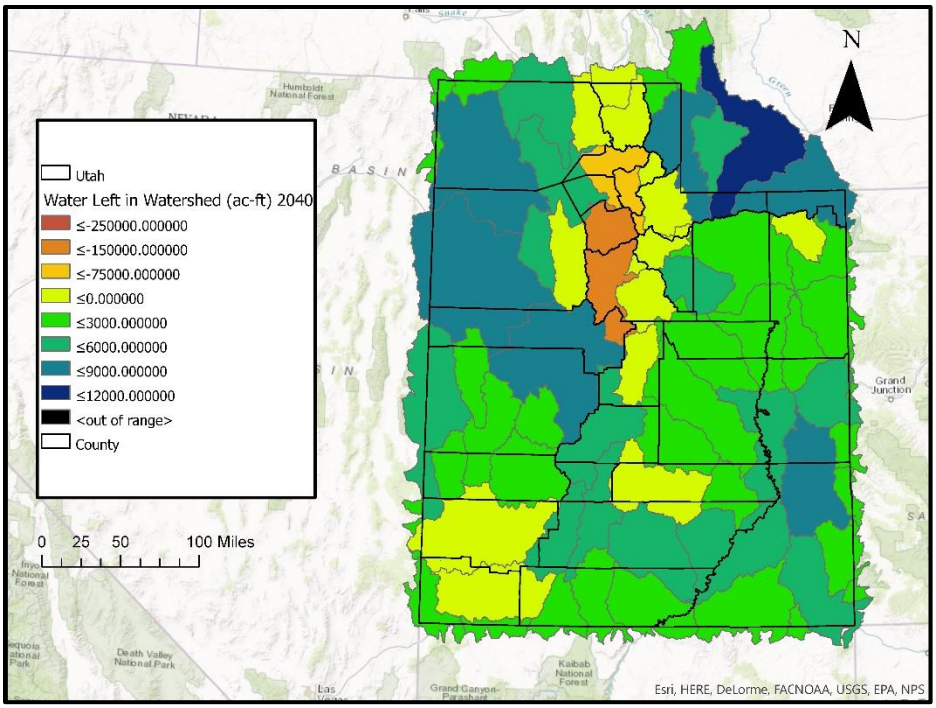

Figure 18 Water Available in Watershed After use 2040

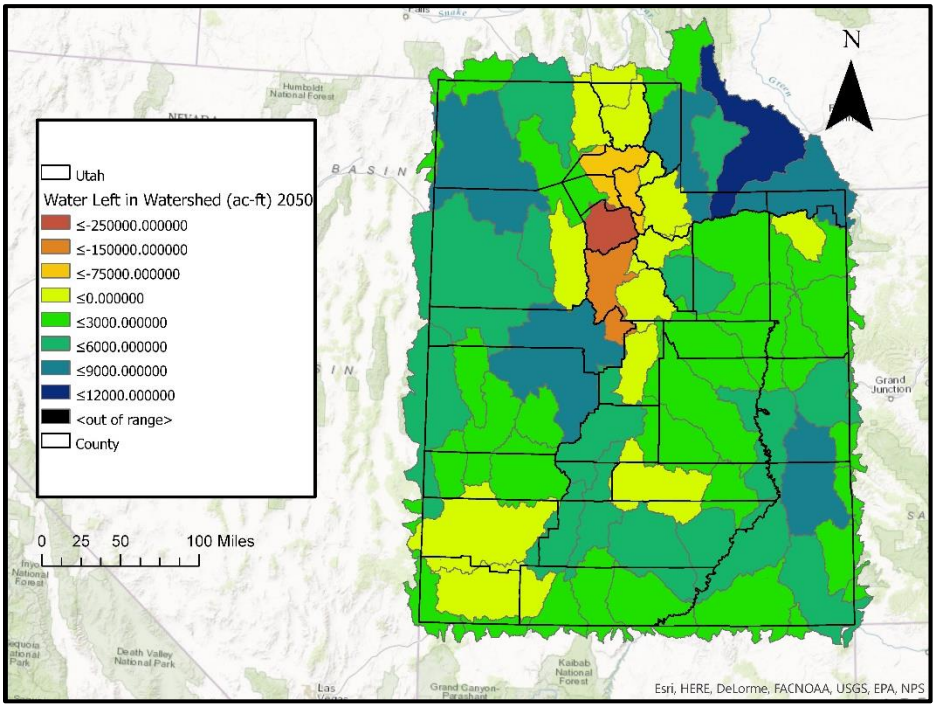

Figure 19 Water Available in Watershed After use 2050

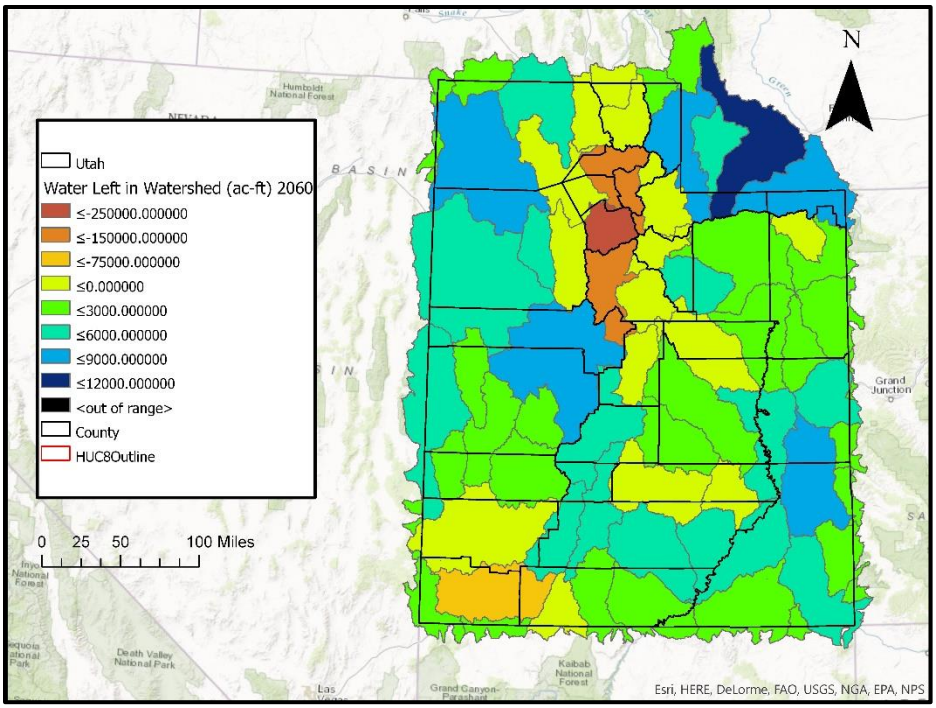

Figure 20 Water Available in Watershed After use 2060

Recommendations

This report analyzes the sustainably of domestic water use for the projected population growth in Utah. This report also provides an effective analysis of sustainability based on domestic water use, which is supplied through municipal systems or through wells. In both cases, the water mainly comes from groundwater, which is recharged through precipitation and some surface water. While surface water wasn't included in this report, only surface water that flows into Utah would change or increase the amount of water available to some watersheds. This analysis can be expanded to include other water resources and uses such as groundwater (to provide an analysis of ground water depletion), surface water (to account for the Colorado River and lakes bordering state boundaries), and other source of water use.

Conclusions

Utah has many attractive qualities for people to live here. Many people choose to stay and live in Utah and raise families. These and other reasons account for the increasing population, which is expected to double by the year 2060. Water resources however don't continue to grow. Utah has a limited volume of water available for agriculture, industrial, commercial, and domestic use. As the population continues to expand, water resources are taxed more and may not provide enough for the coming years. After analyzing the available water resource and domestic water use, Utah has a negative water balance, which will continue to get worse as population increases. Watersheds of interest are located in Salt Lake, Utah, Weber, Morgan, and Davis counties.

Works Cited

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