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4/30/2014

The Water Level of Lake Travis as a Response to Precipitation in Central Texas, 2003-2013

Introduction and Problem

The purpose of this project is to explore how closely related the water level in Lake Travis is to the total precipitation of the area. How does the level of Lake Travis respond to increases and decreases in annual precipitation? How quickly will Lake Travis respond to the abundance or absence of water?

Data Collection

1. Precipitation data requested from National Oceanic and Atmospheric Administration (NOAA) website: http://www.ncdc.noaa.gov/ Travis county data was chosen to represent immediate rainfall close to the lake. Rainfall totals in the watershed areas are taken to mirror average rainfall numbers for the total state because the watershed areas are composed of 20+ counties.
2. Texas-wide precipitation map also obtained from NOAA website. The precipitation data in the state wide map is composed of data from 1960-1991.
3. Shape files for all counties, major water systems, and roads come from the Texas Tech University Center for Geospatial Technology website: http://www.gis.ttu.edu/center/DataCatalog/Download.php?County=Kimble
4. Orthophotos of Travis County and Lake Travis come from the Texas Natural Resources Information System website: http://www.tnris.org/get-data?quicktabs_maps_data=1

5. GIS data for the individual watershed areas for the Highland Lakes chain was not readily available or simply not found. The watershed areas were based upon PDF maps obtained from the Lower Colorado River Authority website: http://maps.lcra.org/default.aspx?MapType=Watershed+Maps Figures 1, 2, and 3.

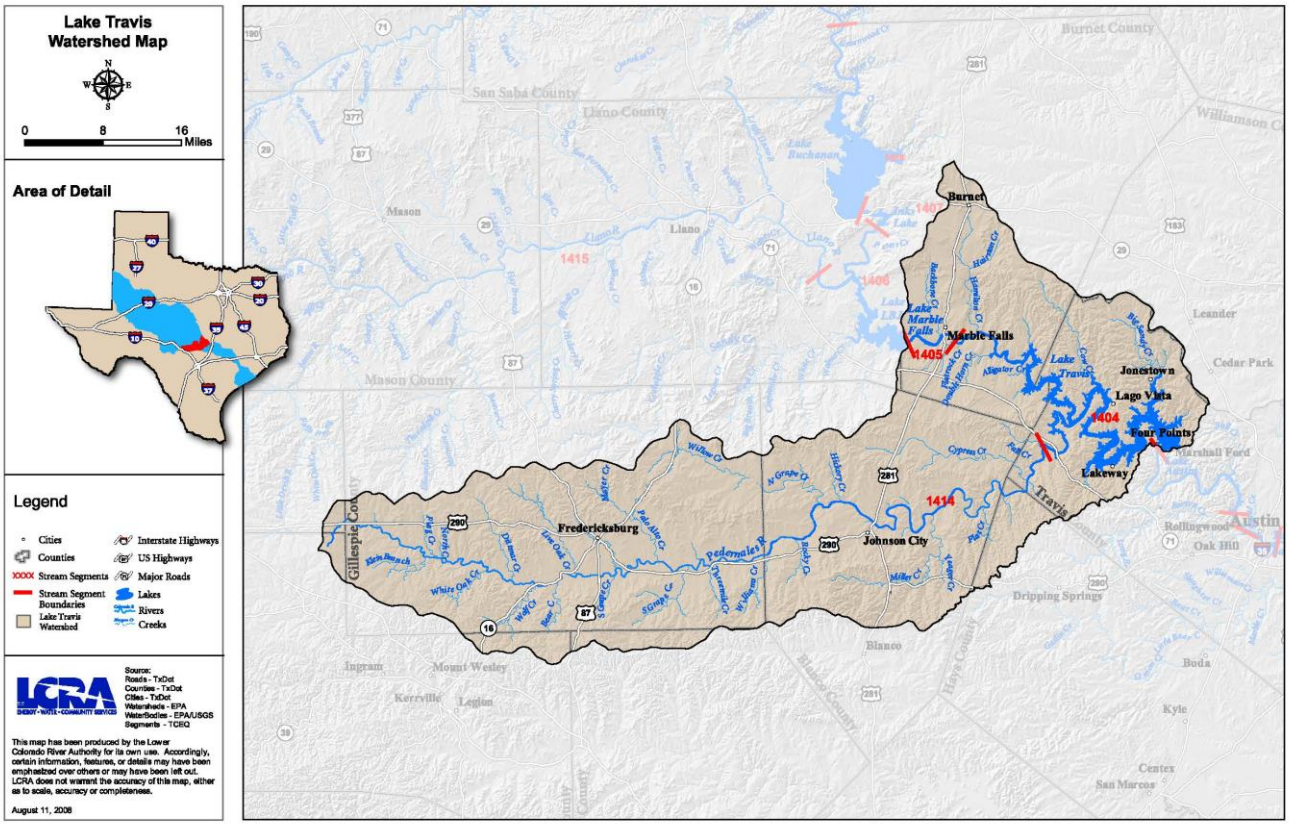


Figure 1. Lake Travis Watershed Map

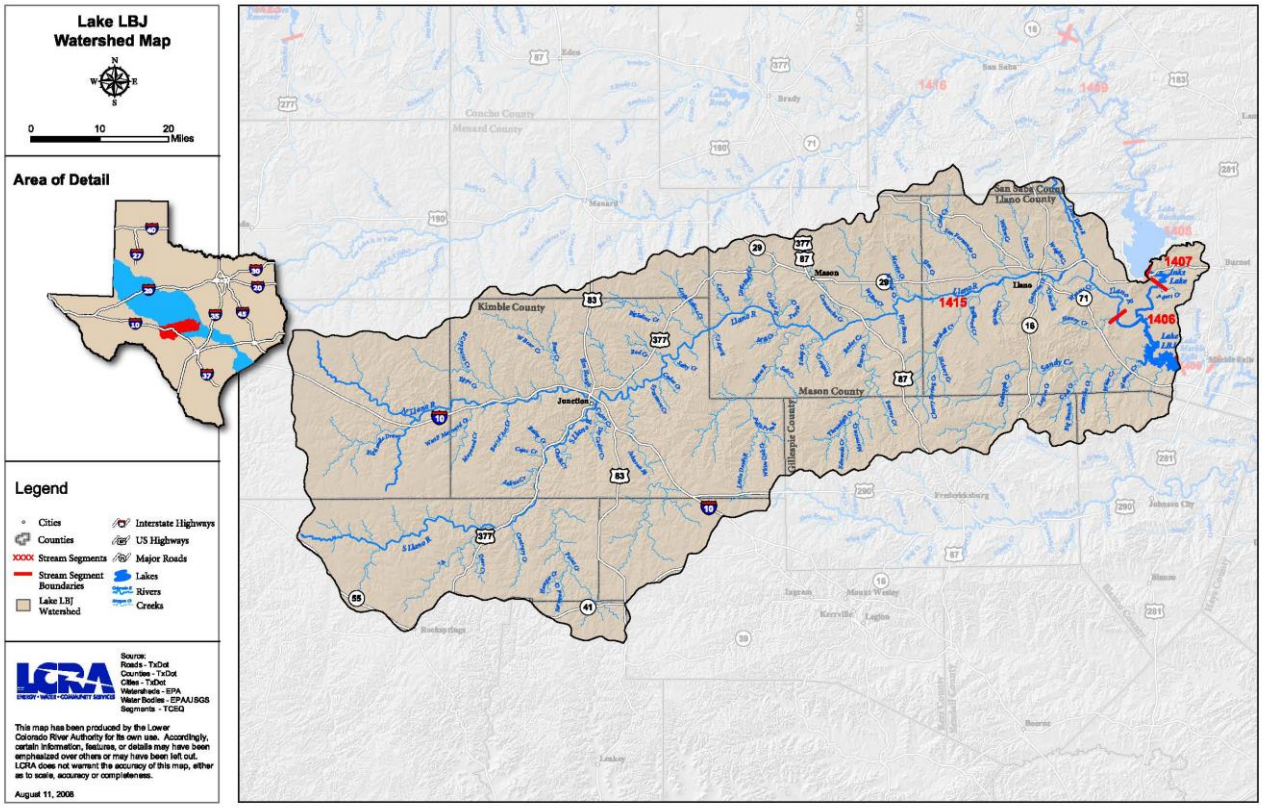


Figure 2. Lake LBJ Watershed Map

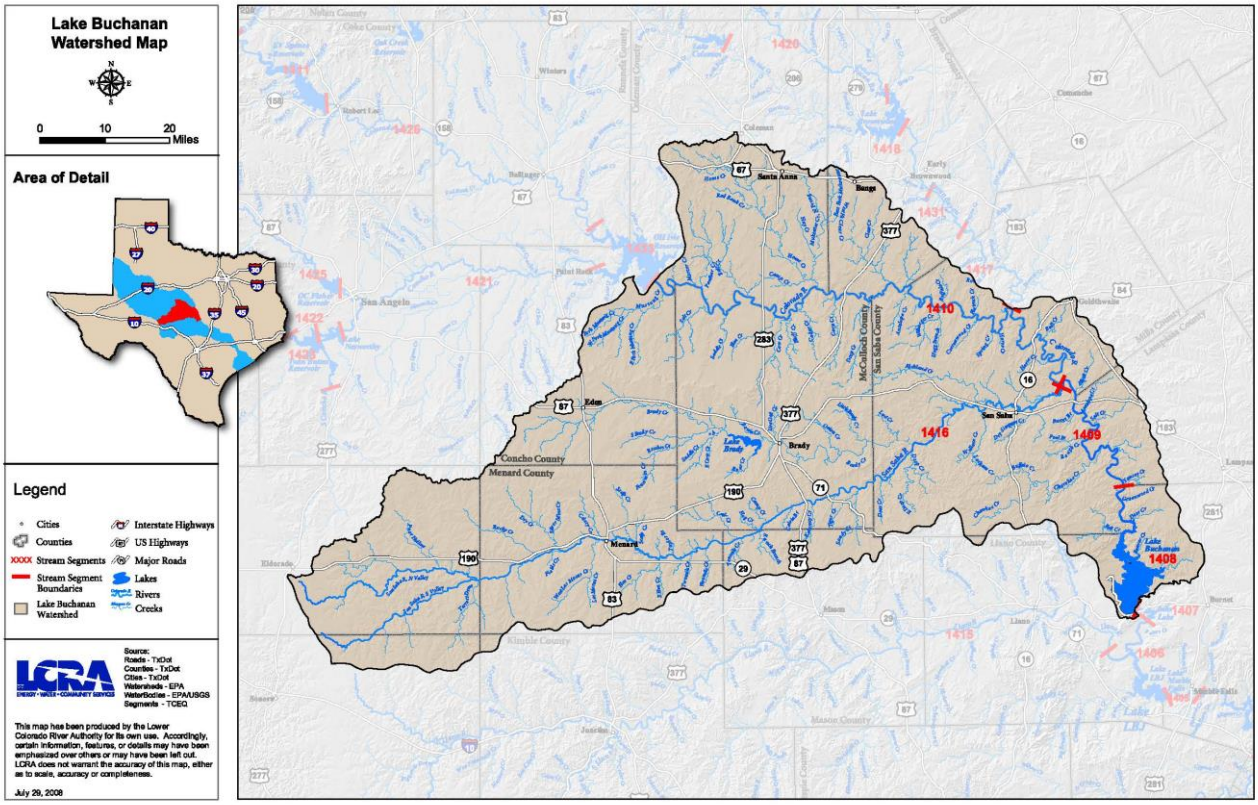


Figure 3. Lake Buchanan Watershed Map

Background

Lake Travis is just one lake in the Highland Lakes system. It is one of two “reservoir” lakes in the chain. The other “reservoir” lake is Lake Buchanan. The “reservoir” lakes can be manipulated in that the flow rate out of the lakes is very precisely controlled. The idea behind the precise control of the outflow rate of the lakes is to always have enough water in the lakes for the surrounding areas to use. In between the two “ reservoir” lakes are three “flow through” lakes: Inks Lake, Lake LBJ, and Marble Falls Lake. The “flow through” lakes are exactly what they sound like. This system of manually controlling the lake level could potentially negatively affect the conclusions drawn from trying to correlate precipitation to lake level. When precipitation is abundant, much of the water can be allowed to flow out of the lake. In times of drought, as much water is kept in the lake as can be safely kept without adversely affecting areas downstream. Going into this project I knew the most drought-burdened year was 2011. The effects of the drought of the past several years is most readily seen in Travis County orthophotos focused on Lake Travis. The best orthophotos that could be found were from 2005, 2008, and 2012. This works well as 2011 is sandwiched on either side by orthophotos. 2005, 2008, and 2012 in figures 4, 5, and 6 respectively.

Figure 4. Lake Travis, 2005

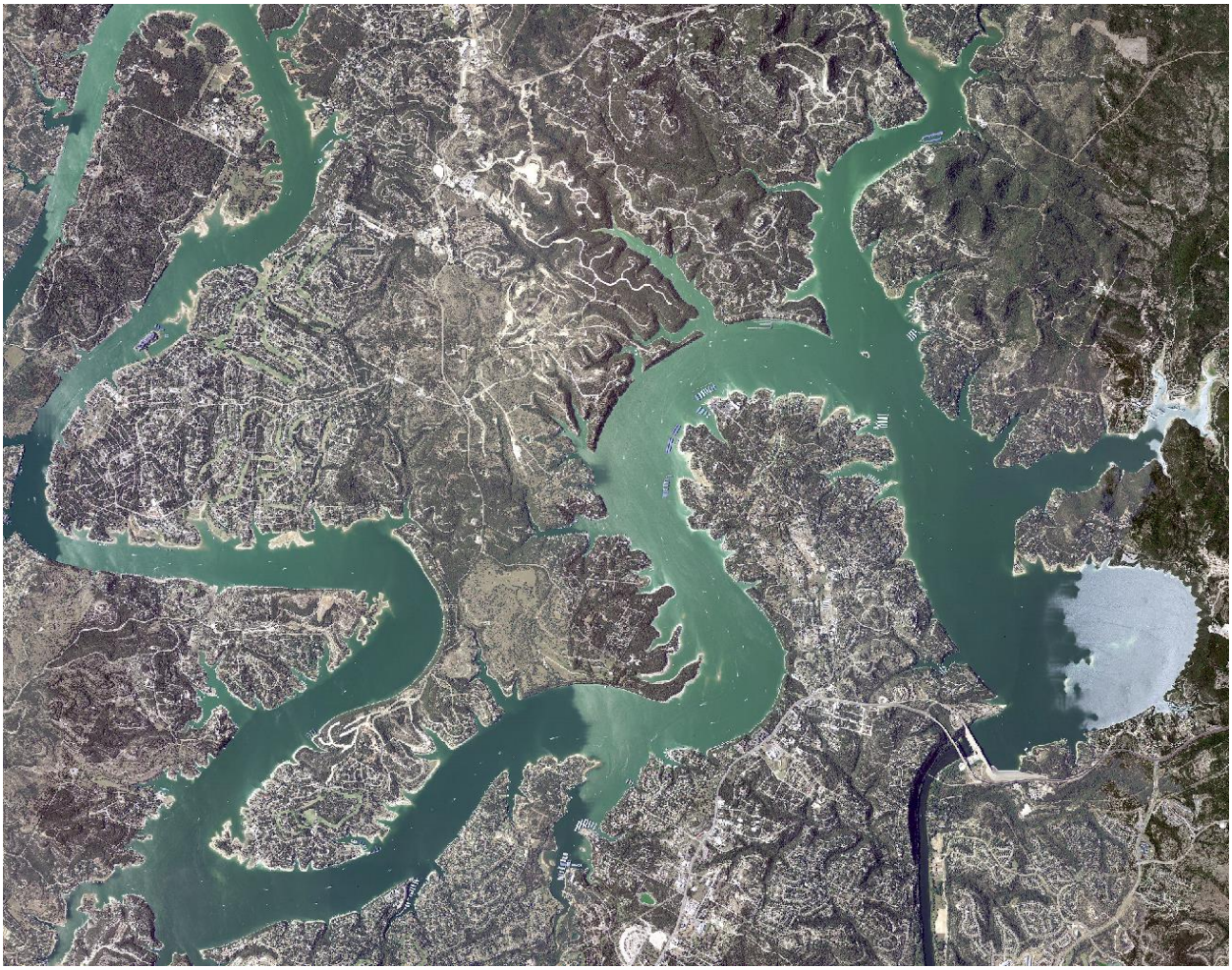


Figure 5. Lake Travis, 2008

Figure 6. Lake Travis, 2012. Effects of drought clearly seen.

Procedure

The Texas counties shape file as well as individual county shape files were first loaded into ArcMap. Figure 7.

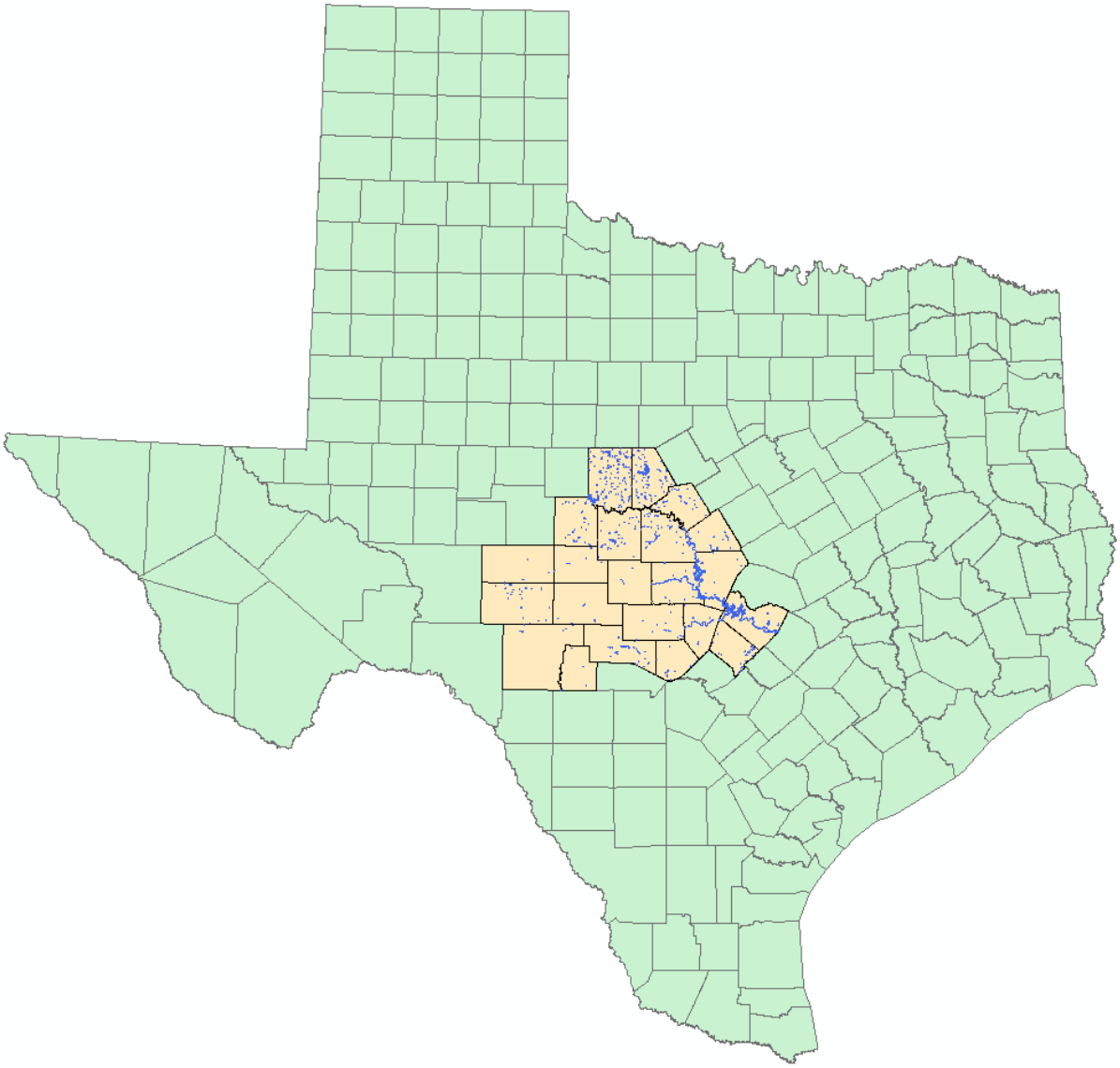


Figure 7. All Texas counties with selected counties in beige. All selected counties are connected to one or many watershed areas.

These counties collectively compose the three major watershed areas for the Highland Lakes chain. Lake Travis is predominantly in Travis County but the water affecting the lake comes from the entire watershed area. The next challenge was to recreate the watershed areas in ArcMap. This process started with the creation of a new Personal Geodatabase labeled Project.mdb, figure 8.

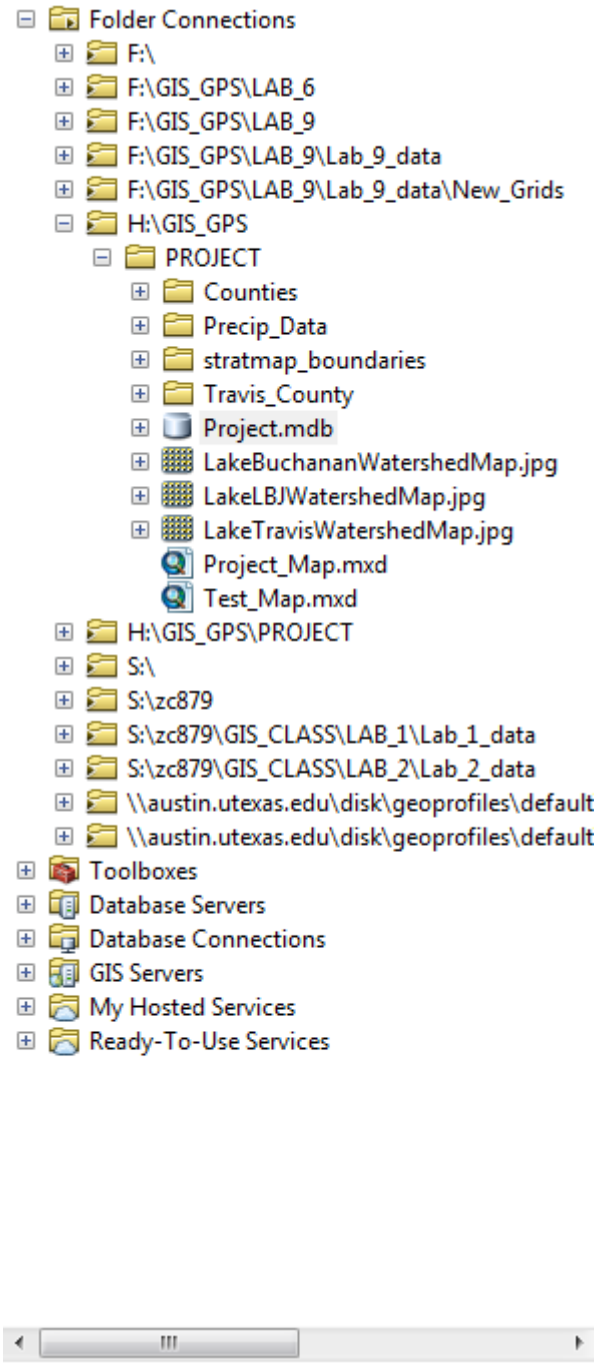


Figure 8. Creation of Personal Geodatabase

The new Geodatabase would become the home for new feature classes to be created. In addition to outside feature classes, a Feature Dataset is also required to hold the feature classes of the polygons that would become the individual watershed areas. The

Feature Dataset also holds the domains that will identify the polygons once they are created, figure 9.

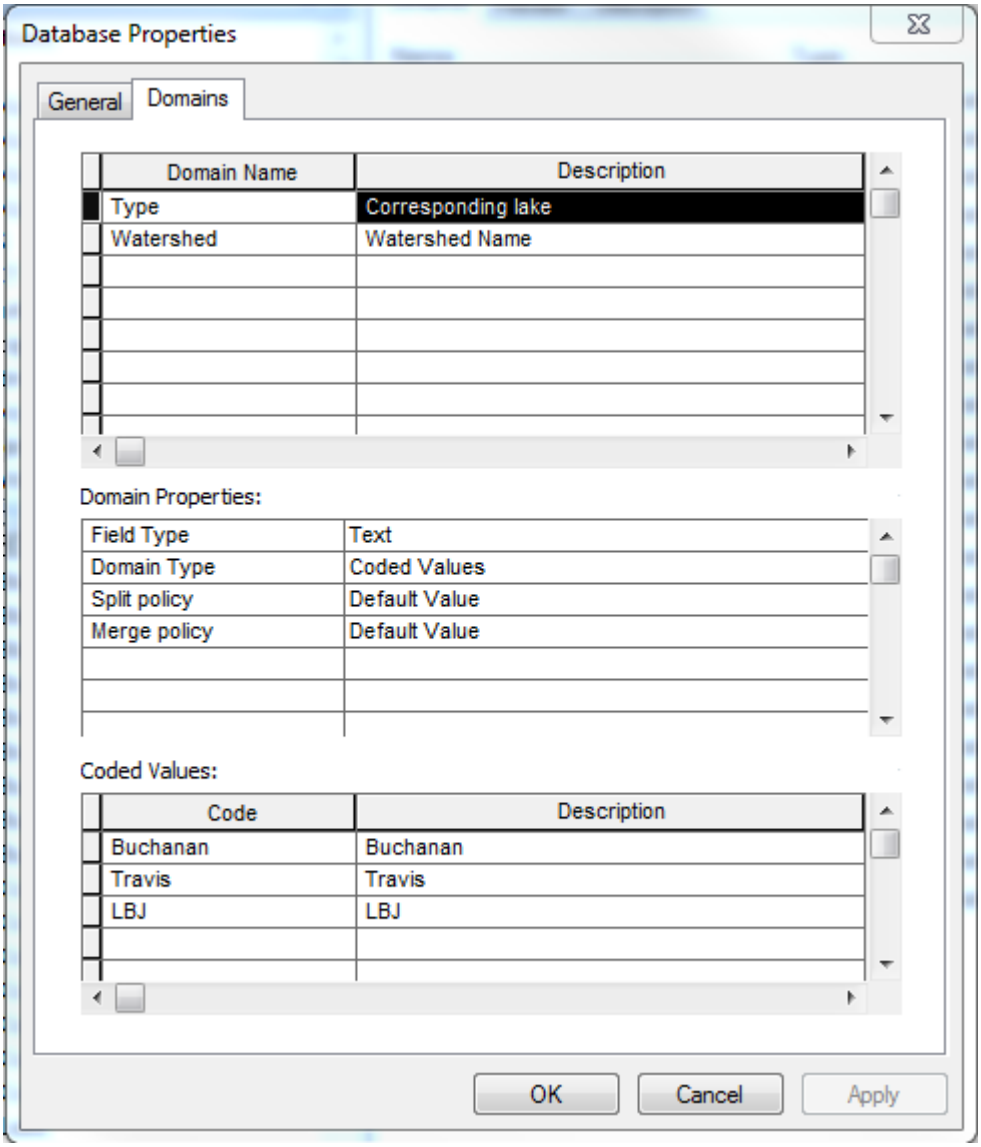


Figure 9. Domain setup

The feature dataset created was named Watershed and holds the feature class Outline. Outline is a feature class created as the result of trying to closely imitate the LCRA watershed areas by making multiple polygons. Following the polygon creation, a

topology class named Watershed_Topology was created to clear errors. Two dangling errors were encountered and fixed, figure 10.

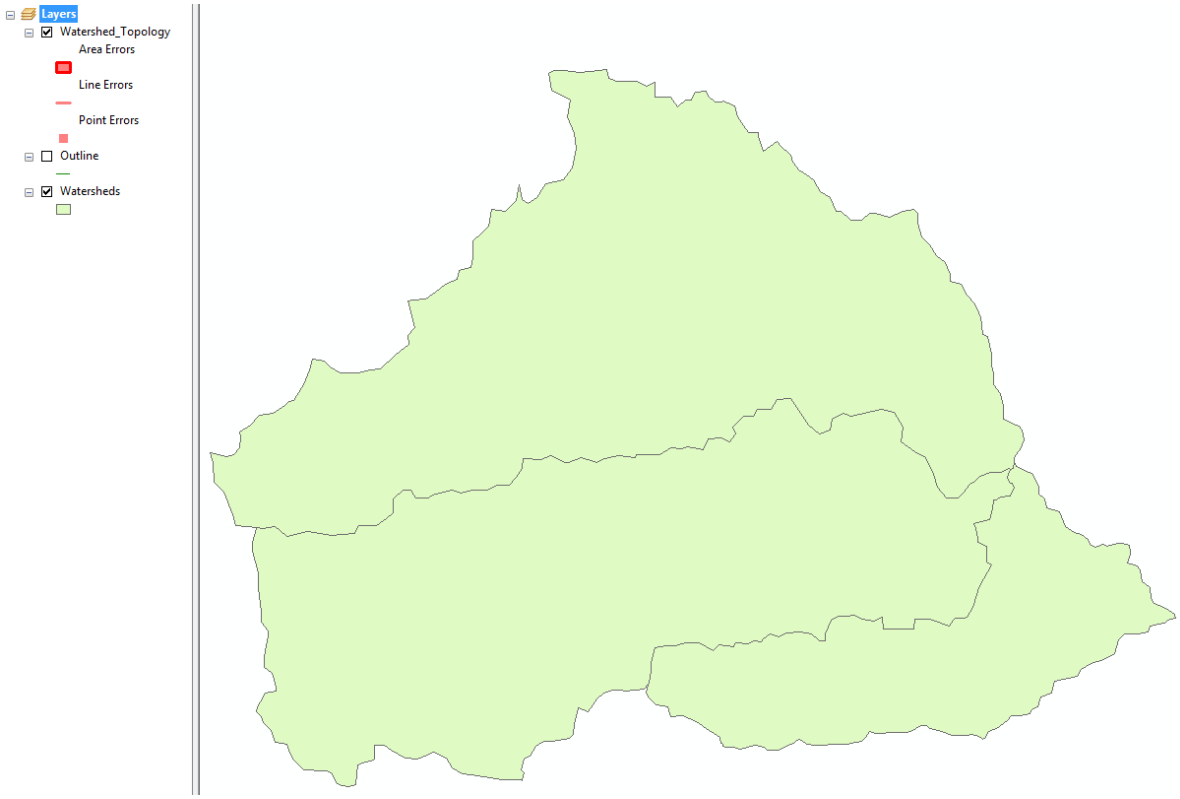
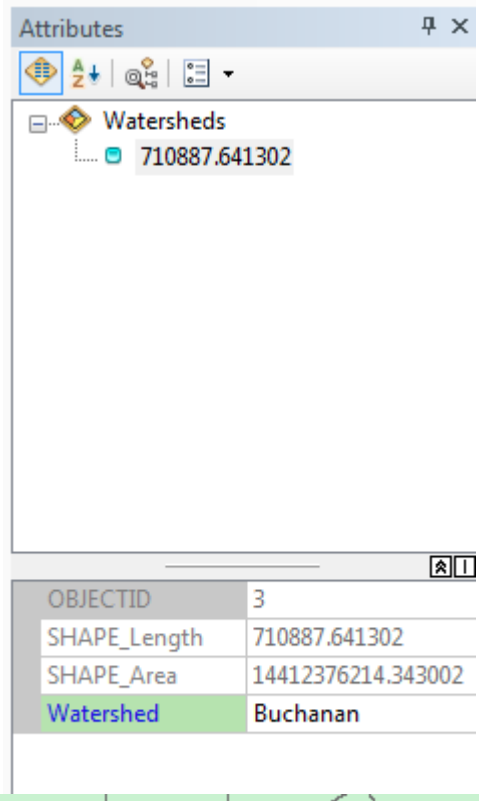


Figure 10. Watershed polygons after creation of topology and error removal

Each polygon is then named by using the previously created domains, figure 11.



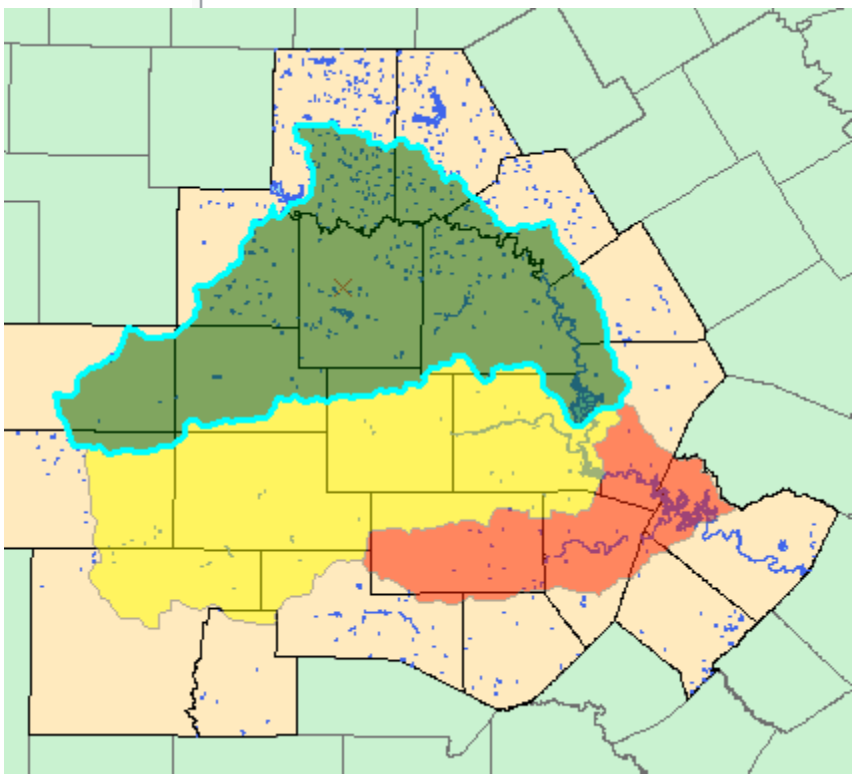
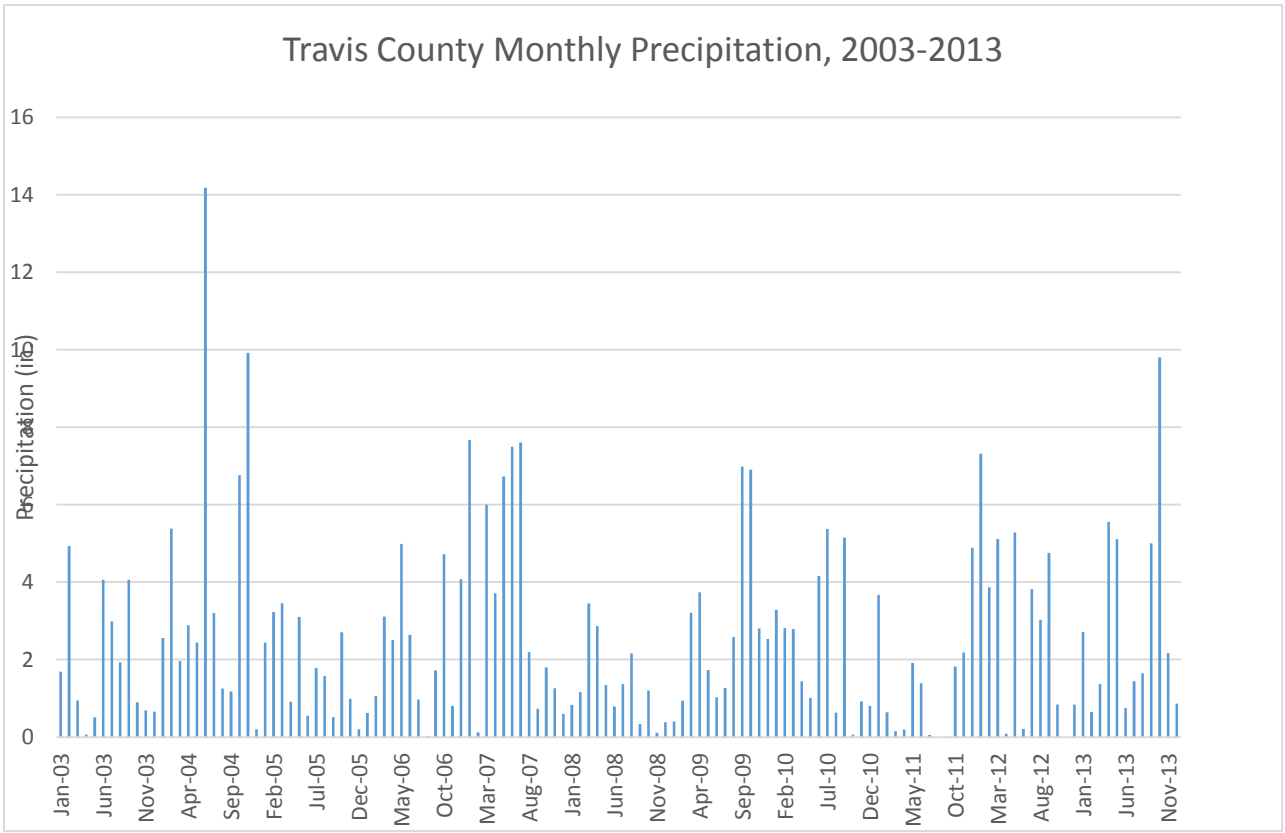
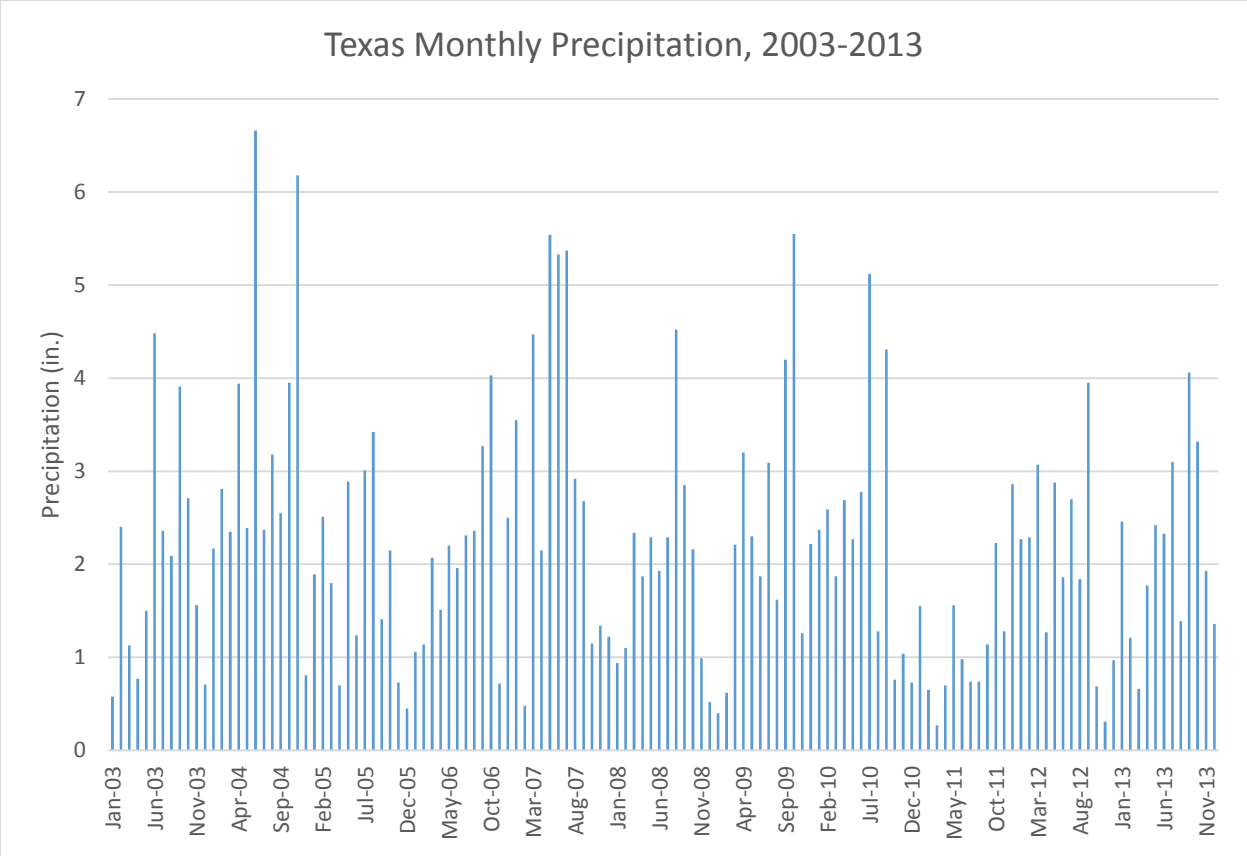


Figure 11. Polygons named using domains.

After the watershed areas were completed, display of the precipitation and lake level data was next. The precipitation data came as monthly values for Travis County as well

as the entire state. As mentioned earlier, because the overall area of all three watershed areas covers 20+ counties, the precipitation of the entire state is taken to represent the general trend of the precipitation in these specific counties. In both charts for state data and Travis County data, it can be seen that the majority of precipitation occurs in the spring and early summer. The year 2011 is certainly an anomaly in that the spring saw incredibly low precipitation numbers and the summer saw almost no precipitation, especially in Travis County, figures 12 and 13. The graph of Lake Travis levels shows that, generally, lake levels are higher in early spring and drop to a low in late summer or early fall. The graph also shows a few greater than average dips at the end of 2006, 2009, and 2011. In contrast to these lows, the periods of 2004-2005 and 2007-2008 saw consistently high lake levels. Overall, however, there is a general downward trend in lake levels from 2003-2013, figure 14.





Figures 12,13. Precipitation in Travis County and Texas, respectively.

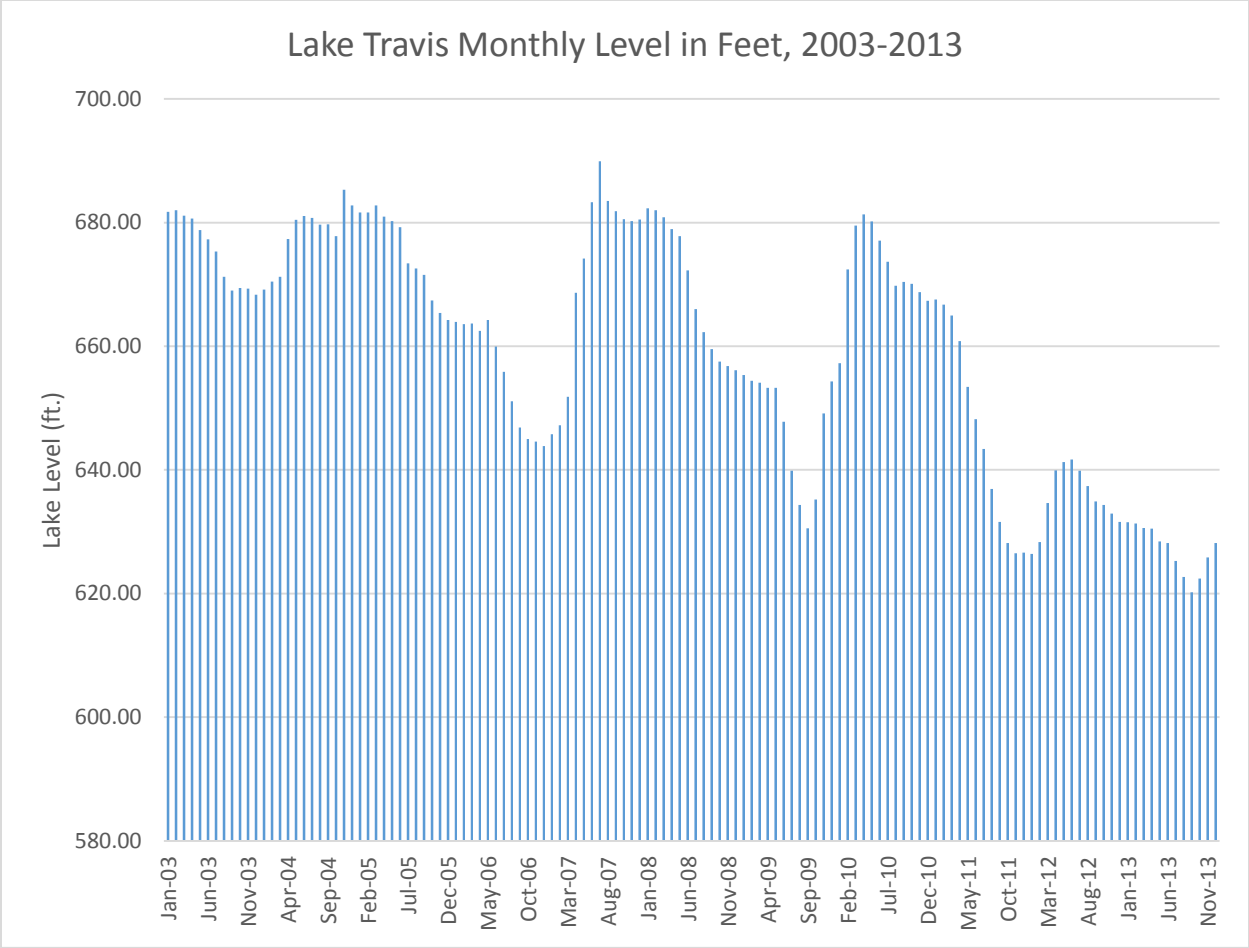


Figure 14. Lake Travis Monthly Levels, 2003-2013

As a comparison, figure 15 shows historically what average yearly precipitation across Texas normally looks like. The data for figure 15 is taken for 1960-1991.

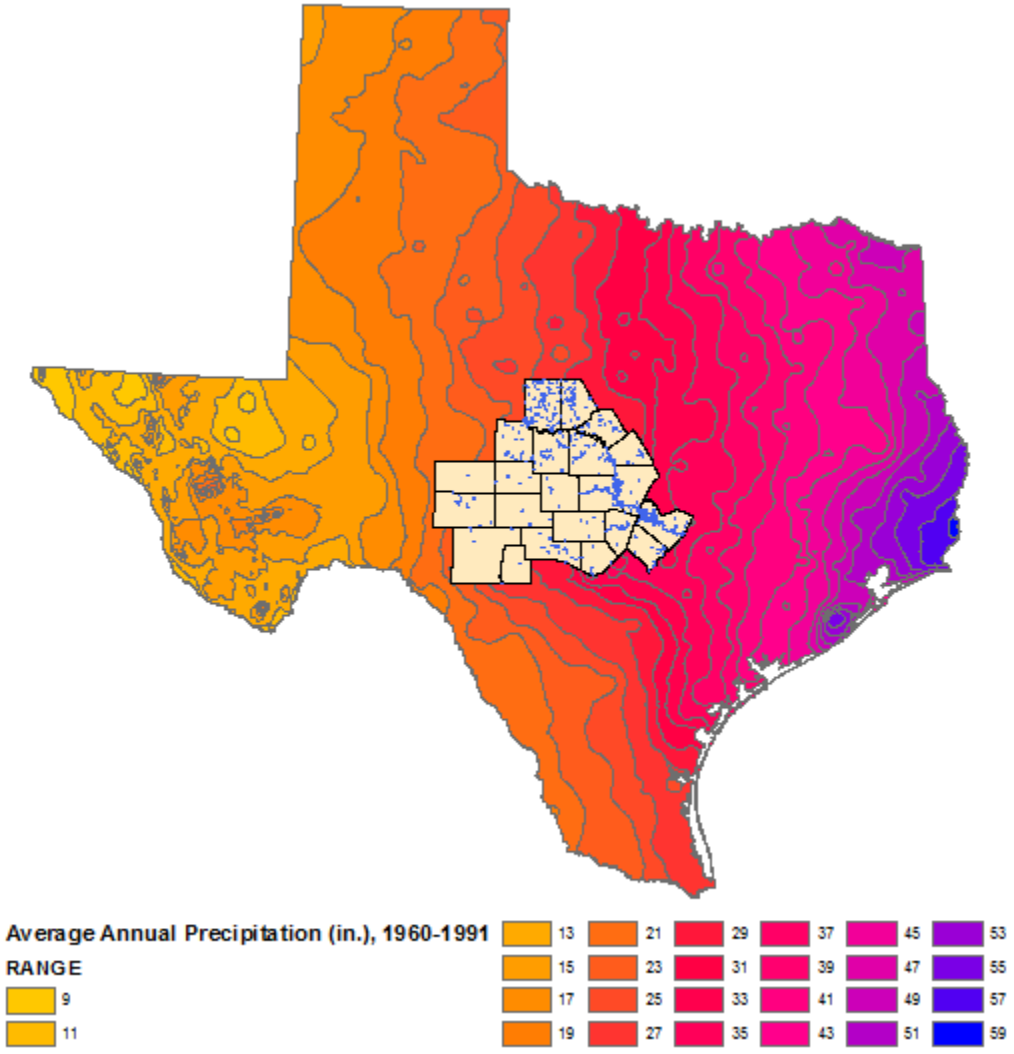


Figure 15. Average Annual Precipitation (in.), 1960-1991

It is also important to note the area of the watershed regions as they relate to water level.

Watershed Area Name	Area (km^2)
Buchanan	14412.38
LBJ	12833.68

Travis	4810.994

The Travis watershed is just over one third the size of both the Buchanan and LBJ watersheds.

Conclusion

The water levels of Lake Travis are closely related to precipitation in the region. The severe lack of precipitation in 2011 can certainly be seen in the sudden drop in lake level shortly thereafter. The overall less than average precipitation in 2012 and 2013 corresponds to the continued decline in level seen in figure 14. The speed at which water level changes can be seen at the one to two month range. However, large swings in precipitation values appear to be rounded out in a gentler curve displayed in lake level data. It is important to understand that, yes, the Highland Lakes are a connected chain sharing all three watersheds to some degree. However, Lake Buchanan at the top of the chain is a reservoir lake that must give away some of its water here and there, but it has the added benefit of a large watershed almost entirely to itself. Then, the middle "flow through" lakes are not manually controlled and only give up water when they are full or nearly so. These lakes tend to stay close to full at a near constant level. Also, the middle three lakes share a very large watershed in LBJ which is almost the size of the Buchanan watershed. At the bottom of the upper portion of the chain sits Lake Travis. It is disadvantaged with a watershed just over one third the size of the upper two watersheds and only receives water from the upper lakes when there is ample precipitation. It can be concluded, then, that Lake Travis has suffered due to the drought

conditions in recent years as well as the fact that it has an undersized watershed and sits below three “flow through”, near constant level lakes.

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Upper Highland Lakes Watersheds and Participating Counties, Central Texas