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12/4/14

Comparing and linking runoff and hypsometric properties and there effects on erosion.

PROBLEM/INTRODUCTION

Hypsometric analysis is used in hydrology to analysis the relationship between topography, runoff, flooding and erosion. By using GIS tools, hypsometric properties and runoff properties can be correlate to identify areas in Texas that will be more prone to erosion. Understanding the conditions that promote erosion and being able to locate where this is most likely to occur can help in the future decision of construction of things like reservoirs, damns, and cities.

OBJECTIVE

The purpose of this project is to develop a map that will locate areas of greater potential runoff by comparing and linking runoff properties and hypsometric properties in the watersheds of Texas. This As a result of this analysis, the map developed can be used to identify the factors that cause greater runoff and plans can be put into place to mitigate the effects of runoff and promote aquifer recharge.

METHOD

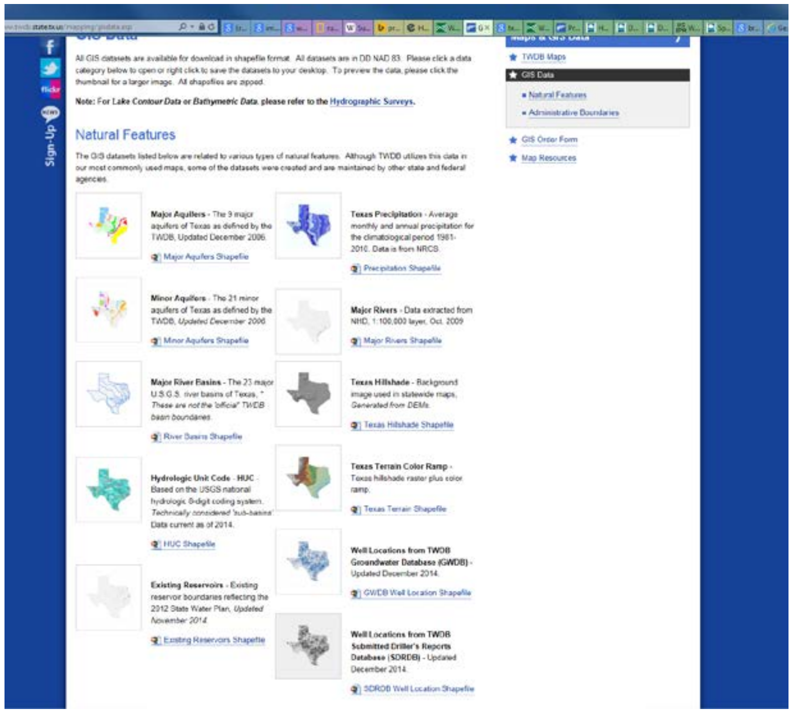
The method will be to first gather precipitation, soil, elevation, and flow data from government agencies and convert them into usable GIS data. This data will be used for the spatial analysis of the relationship between topography, overland flow, and precipitation.

DATA GATHERING

Data and Tools

1. Shapefiles
    a. Texas Water Development Board (TWDB)
        i. Major River Basin
        ii. Major River
        iii. Hydrologic Unit Code-HUS (streams)
        iv. Texas Precipitation 1981-2010
    b. Texas Parks and Wildlife Department (TPWD)
        i. Counties
        ii. Average Annual Regional Precipitation
    c. Texas Commission on Environmental Quality (TCEQ)
        i. Shapefiles:
            1. TCEQ Segments
            2. (Surface Water Rights and Flowlines)
2. DEM
    a. ESRI
        i. 30 arc-second DEM of North America (Data Basin Dataset)
3. GIS Tools
    a. ESRI
        i. Hypsometric Toolbox

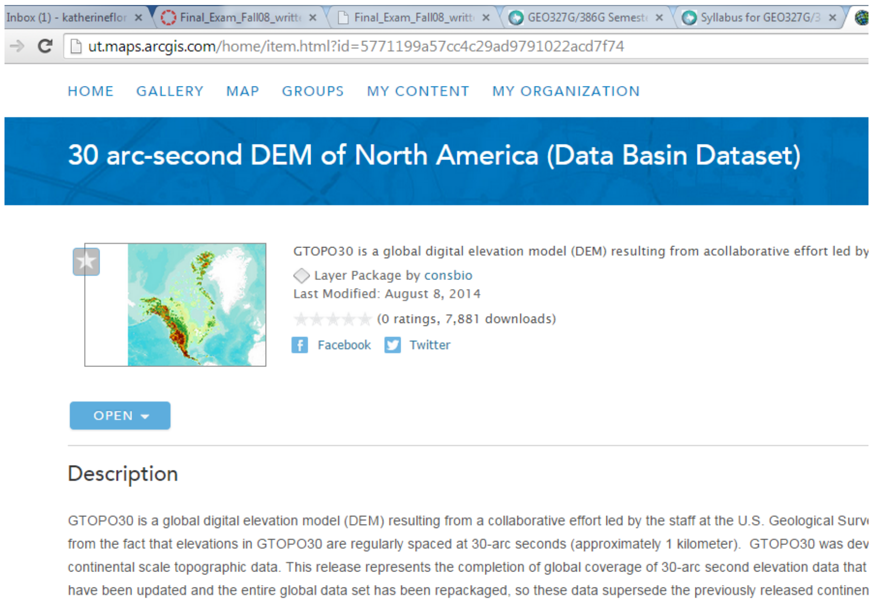
The sites below are where the shapefiles, DEM, and toolbox were downloaded from.

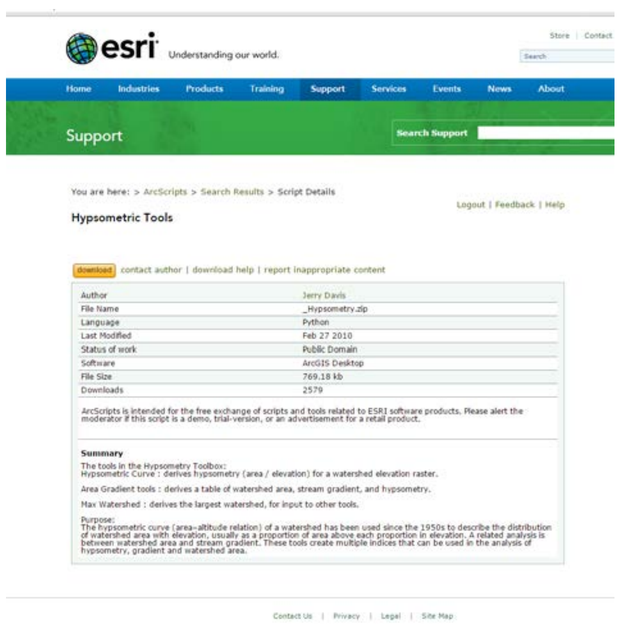


Texas Water Development Board

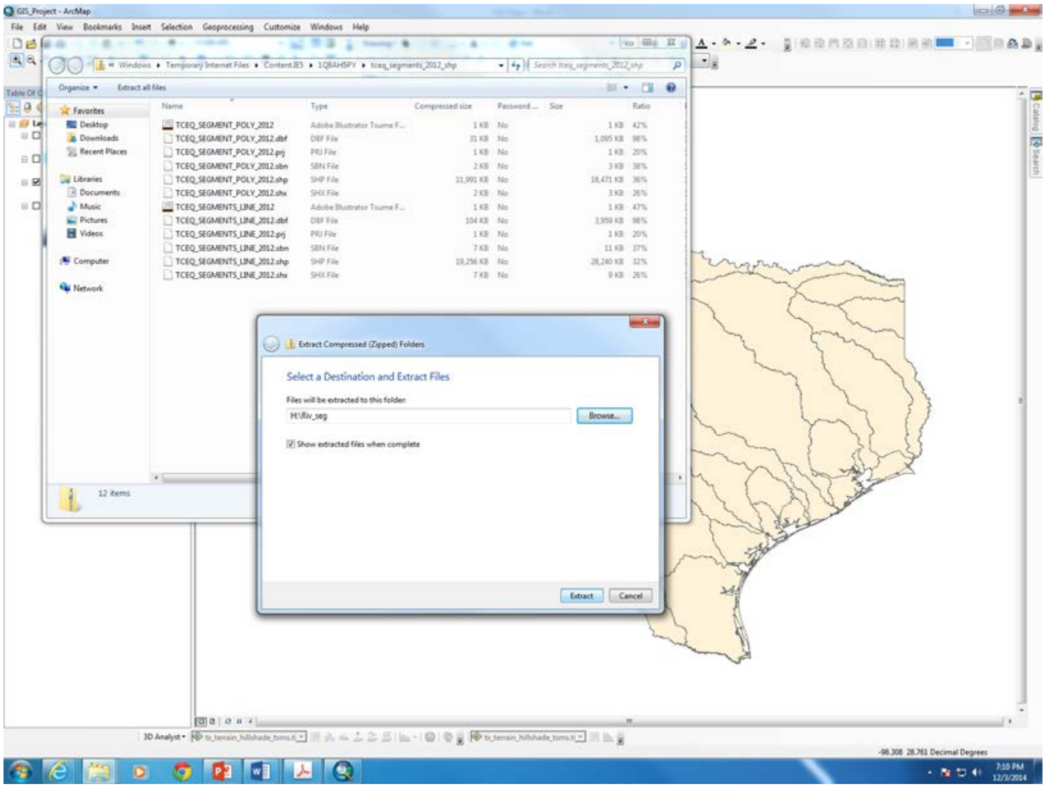
Texas Commission on Environmental Quality

ESRI:

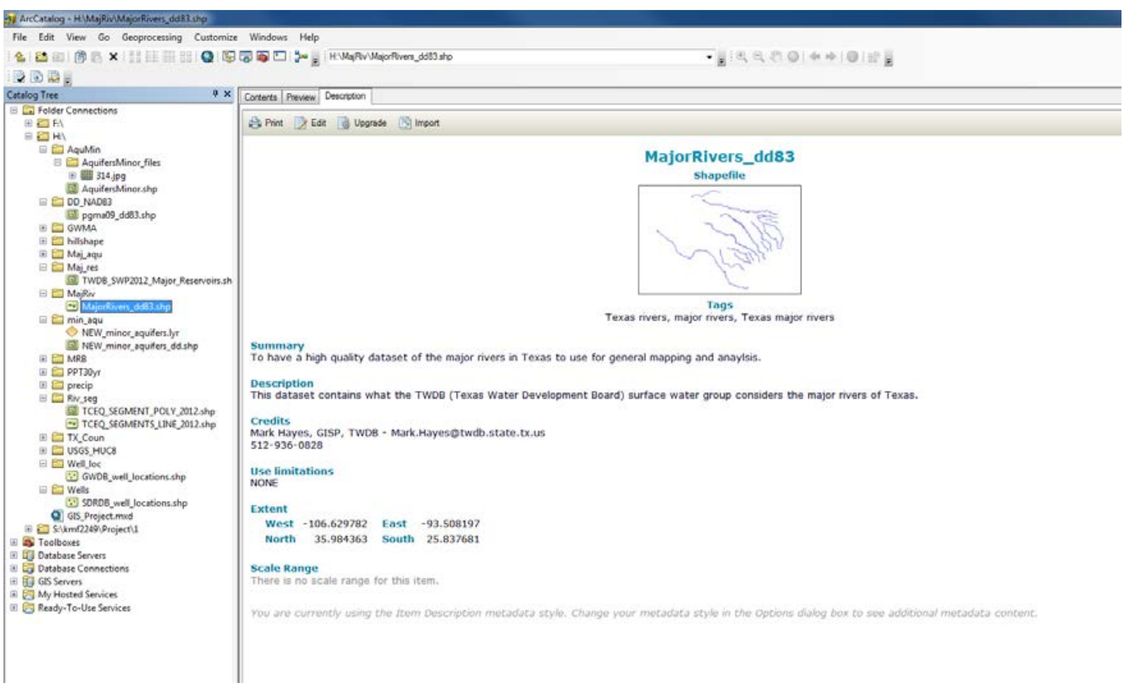




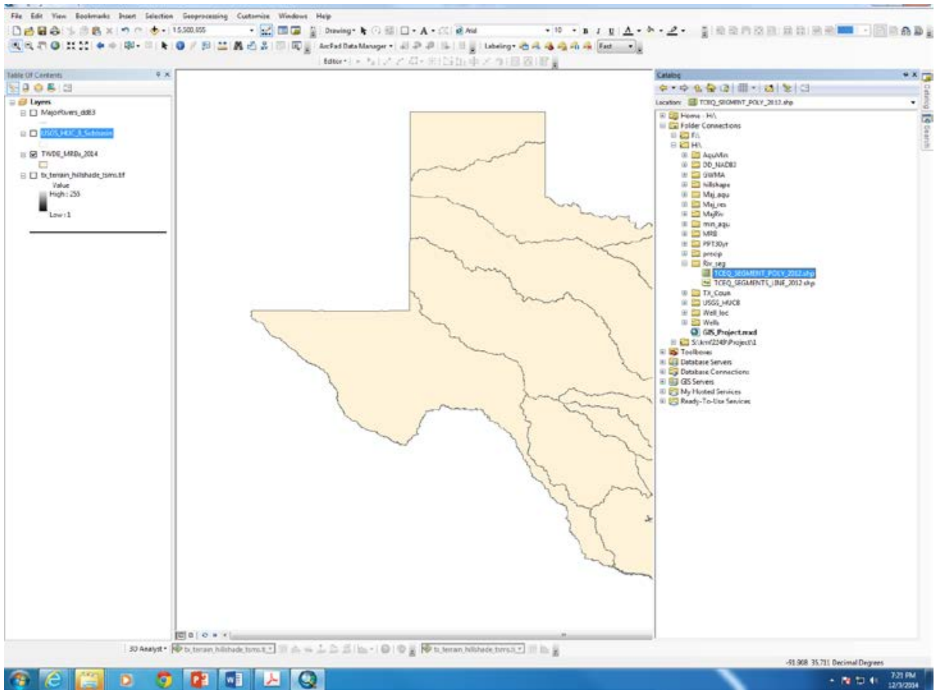
After downloading the data, I proceeded to extract the downloaded files and save them to my USB. Then, I used ArcCatalog to check that the metadata was copied properly and not data was lost. Newt, I opened a new ArcMap and imported the files by dragging and dropping them from the catalog within arc map to the data frame.



Extraction



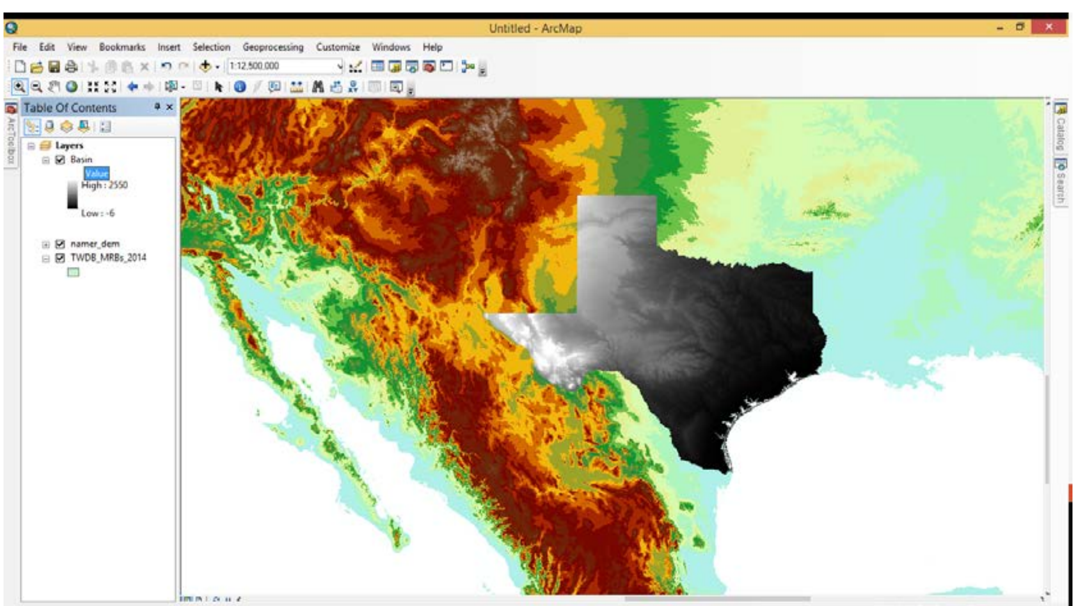
Metadata Check



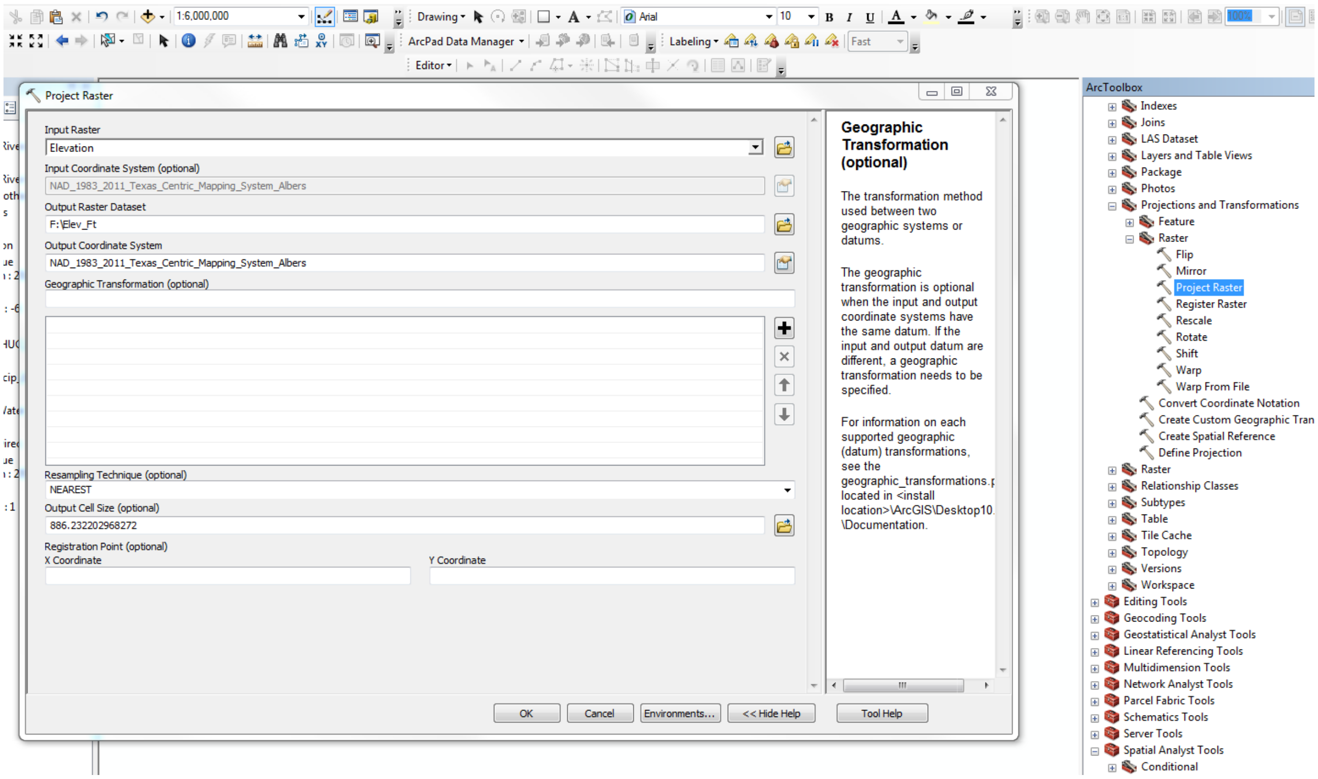
Data imported by drag and drop.

DATA PROCESSING

Now that all the needed materials were imported, I took the DEM and extracted by mask the state of Texas using the Major River Basin shapefile, as the mask, resulting in a new black and white scale raster in the shape of Texas.



I took the new raster was in units of feet and the data frame was in decimal degrees. I changed the data frame and projected the raster (using Project Raster in the raster toolbox) into NAD 1983 2011 Texas Centric Mapping System Albers (meters) so that they would have the same type of units which would allow for easy/correct spatial analysis.



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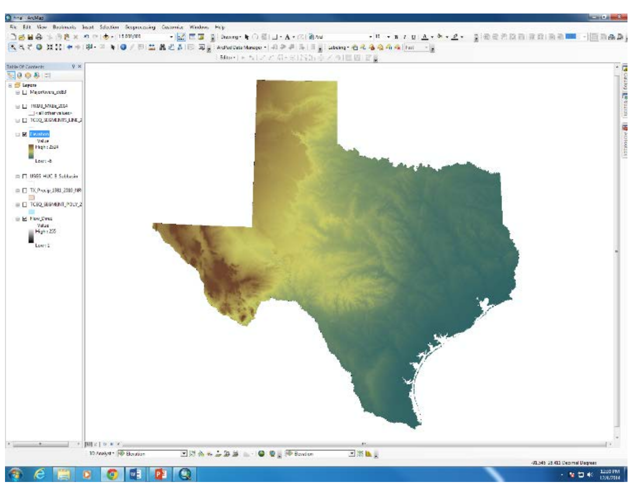
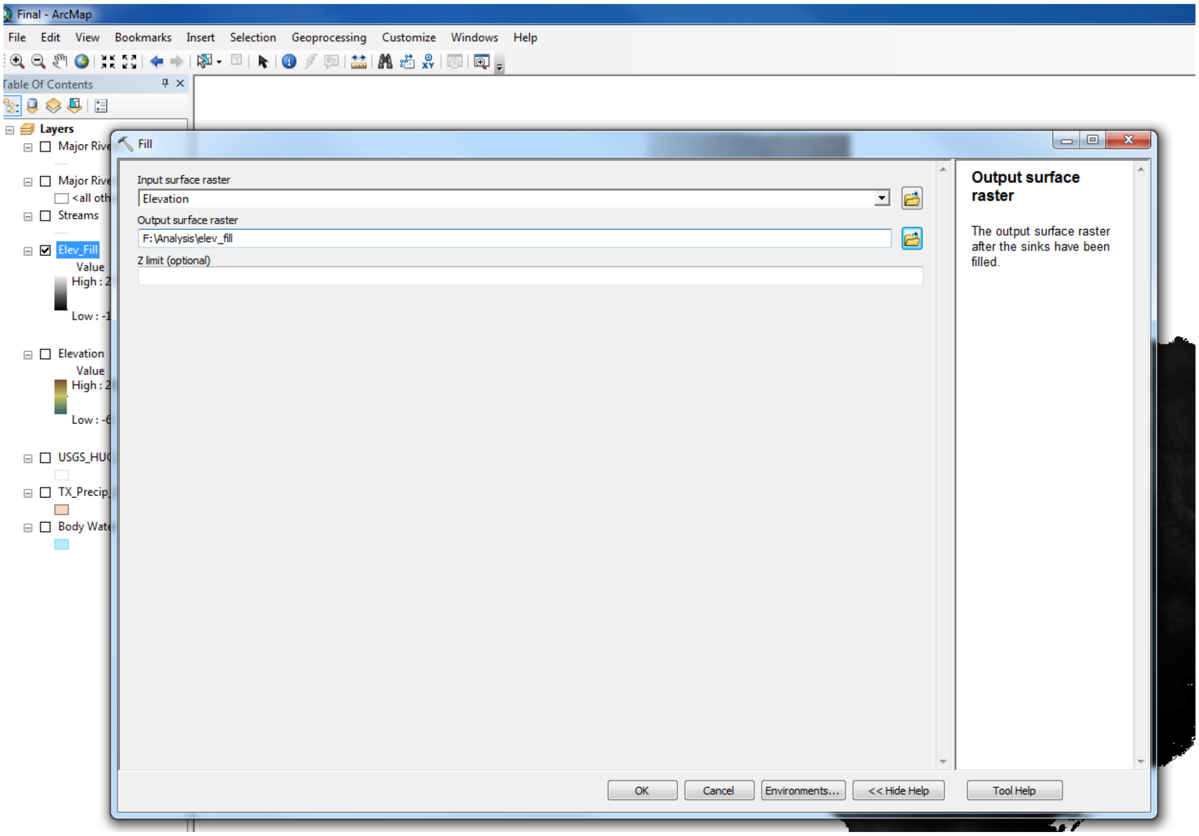
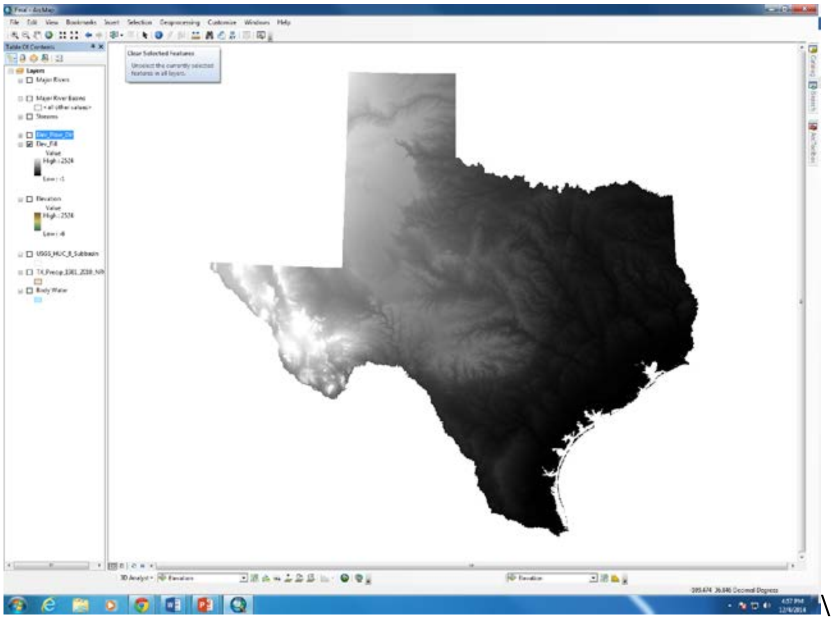
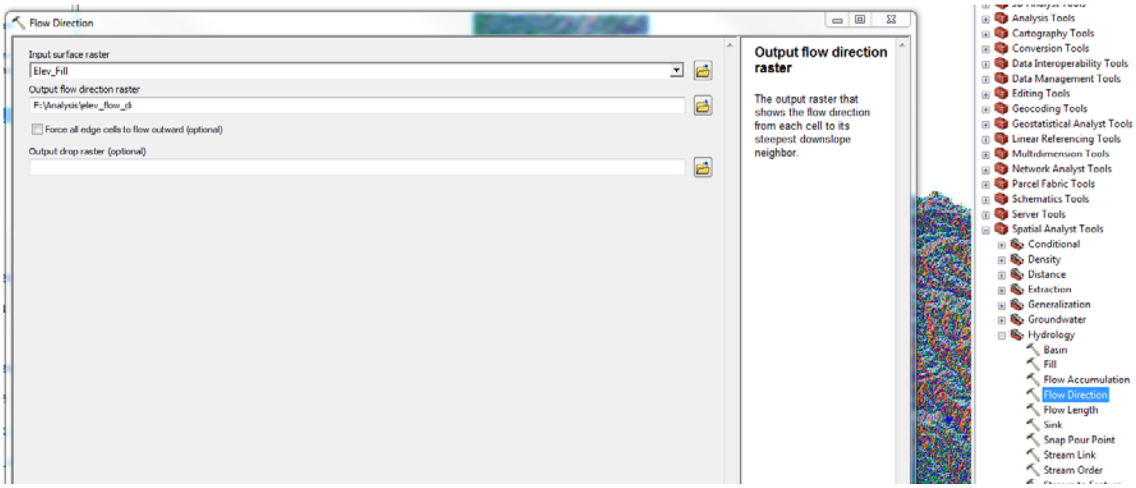
Next, I changed the colored from black to white : brown to blue green diverging just to view the elevation better.

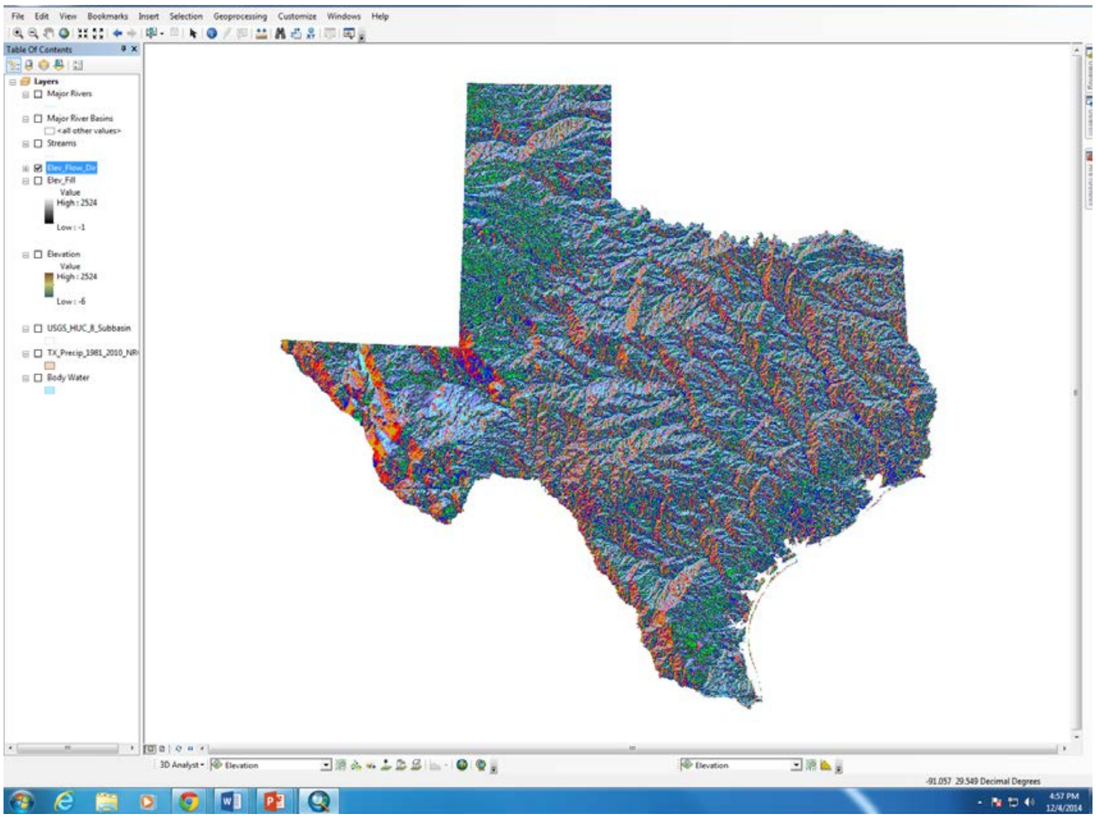




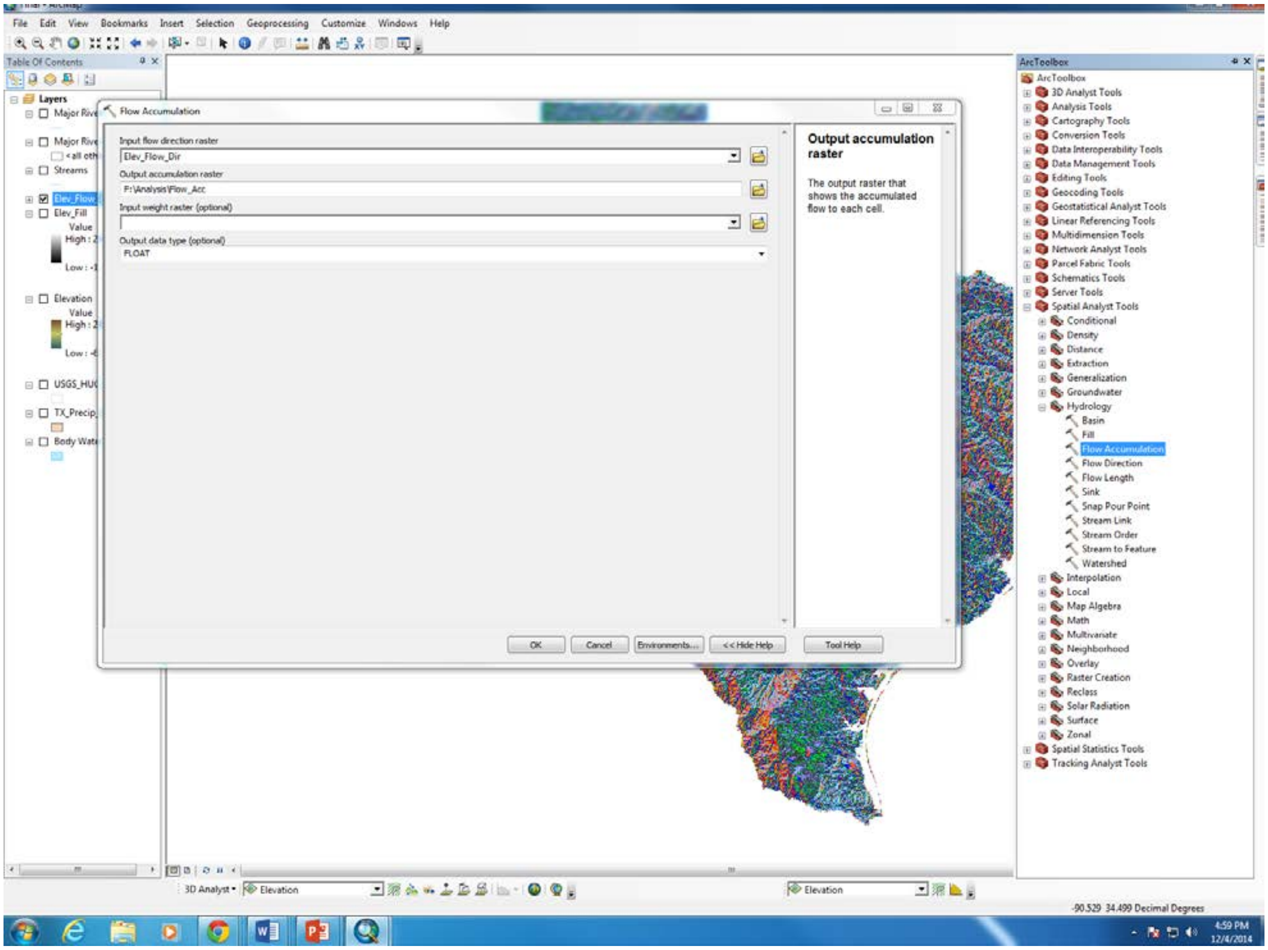


I used the previous elevation raster and the fill tool in hydrology toolbox to make the filled elevation raster seen above.

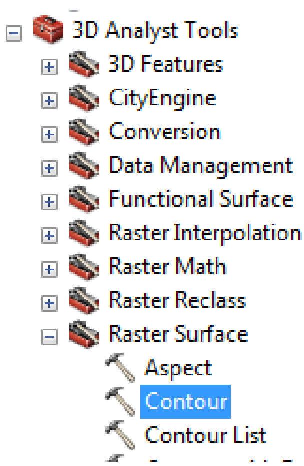




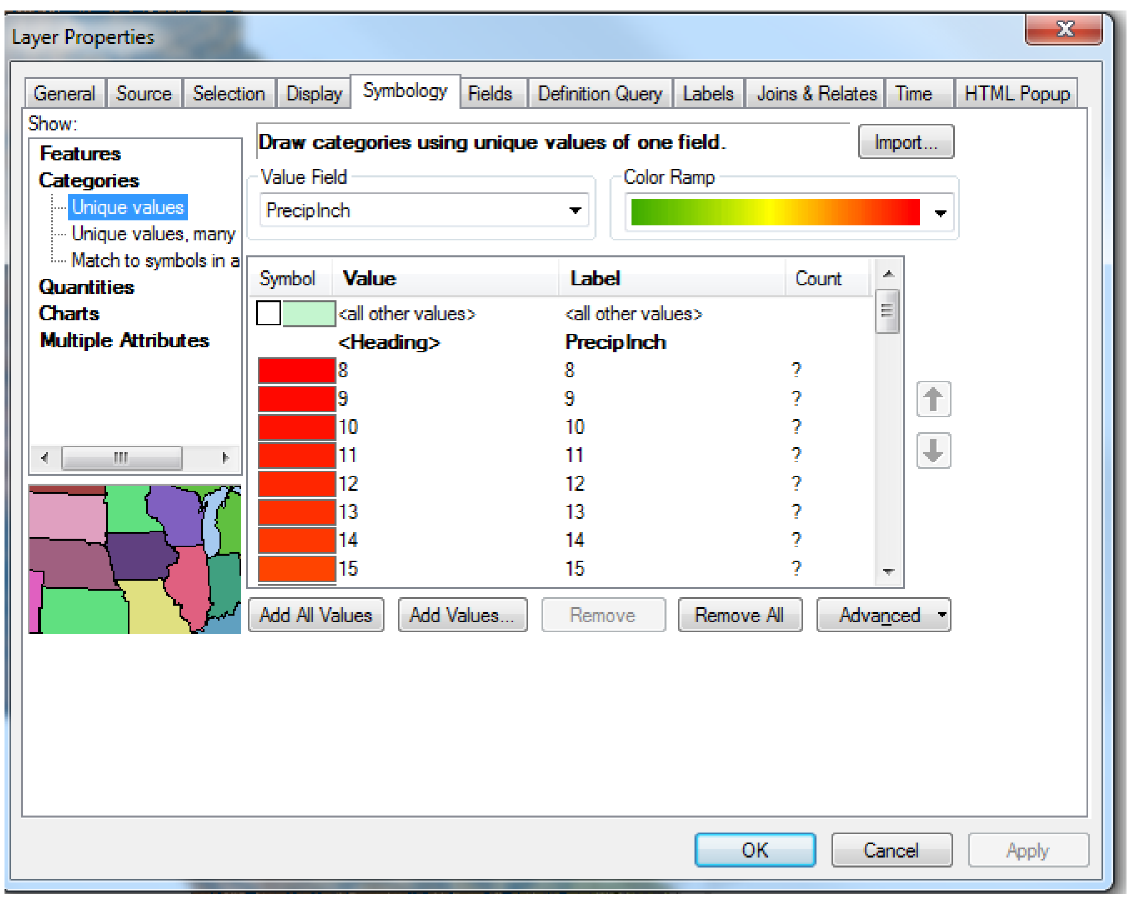
I used the previous filled elevation raster and the flow direction tool in hydrology toolbox to make the flow direction raster seen above.



I used the flow direction raster and the flow accumulation tool in hydrology toolbox to make the flow accumulation raster seen above.



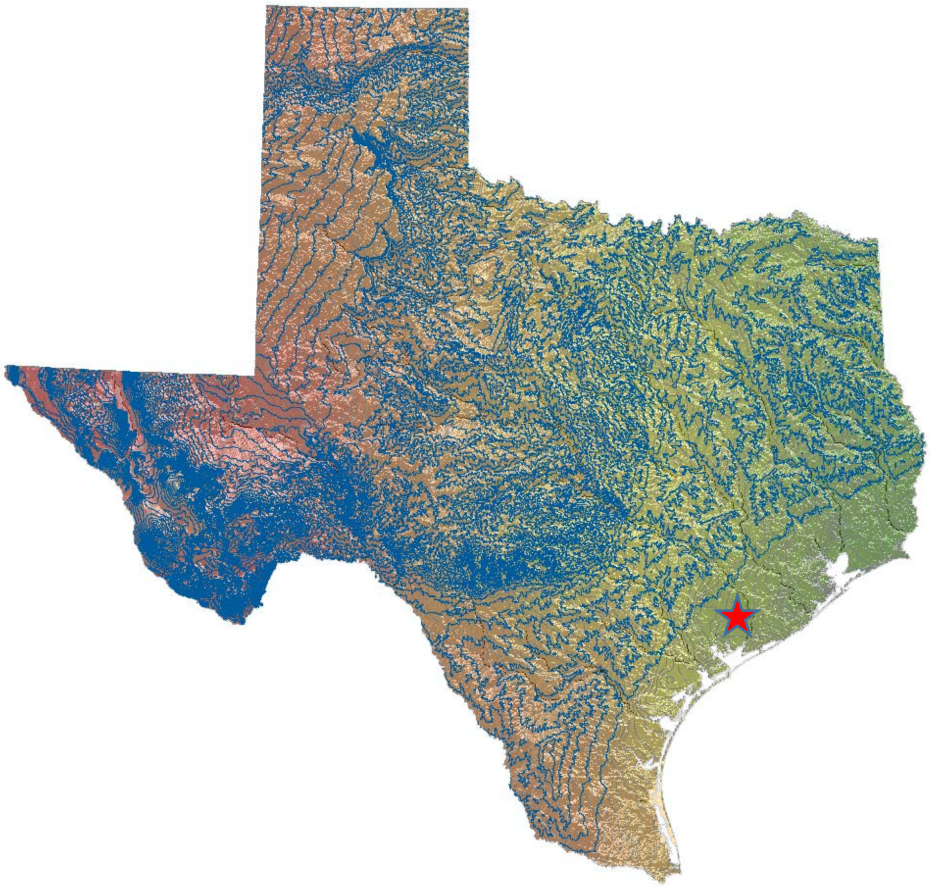
Using the 3D analyst raster surface contour tool, I make a 50 meter interval contour lines from the filled elevation raster. Then I added my precipitation layer and changed the symbology so that the precipitation would be colored by its average value.



I have now converted every original files to files I will use for analysis.

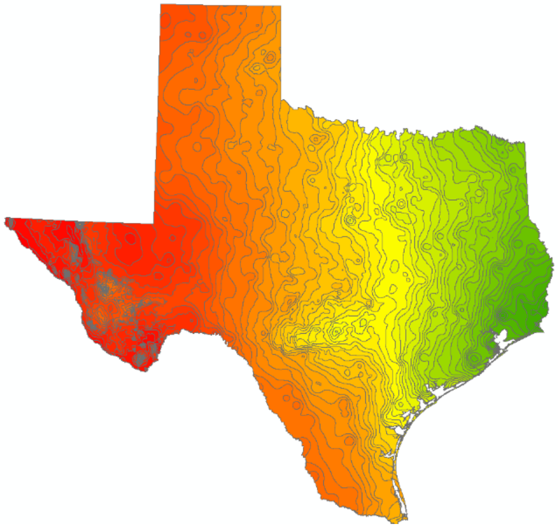
DATA ANALYSIS

Using the symbology and display tabs, I changed the colors and transparencies of the flow direction and accumulation rasters. I then over laid them to show how elevation and flow direction correlate. The water will flow from high elevation to low elevation. Then I added (turned on) the 50m contour lines and the precipitation layers (image on next page). With all four layers turned on, areas of very steep elevation and low rain fall can be identified in West Texas. In Central Texas, there are some steep elevation changes (it is the hill country after all) but the changes are not nearly as steep as West Texas. The Panhandle has a gradual change in elevation that appears to correlate with the southern tip of the Ogallala aquifer. The East/Southeast part of Texas and both have a gradual change in their elevation. Like in the Panhandle, there change is so gradual that it would appear flat and more so the further you travel towards the coast.



RESULTS

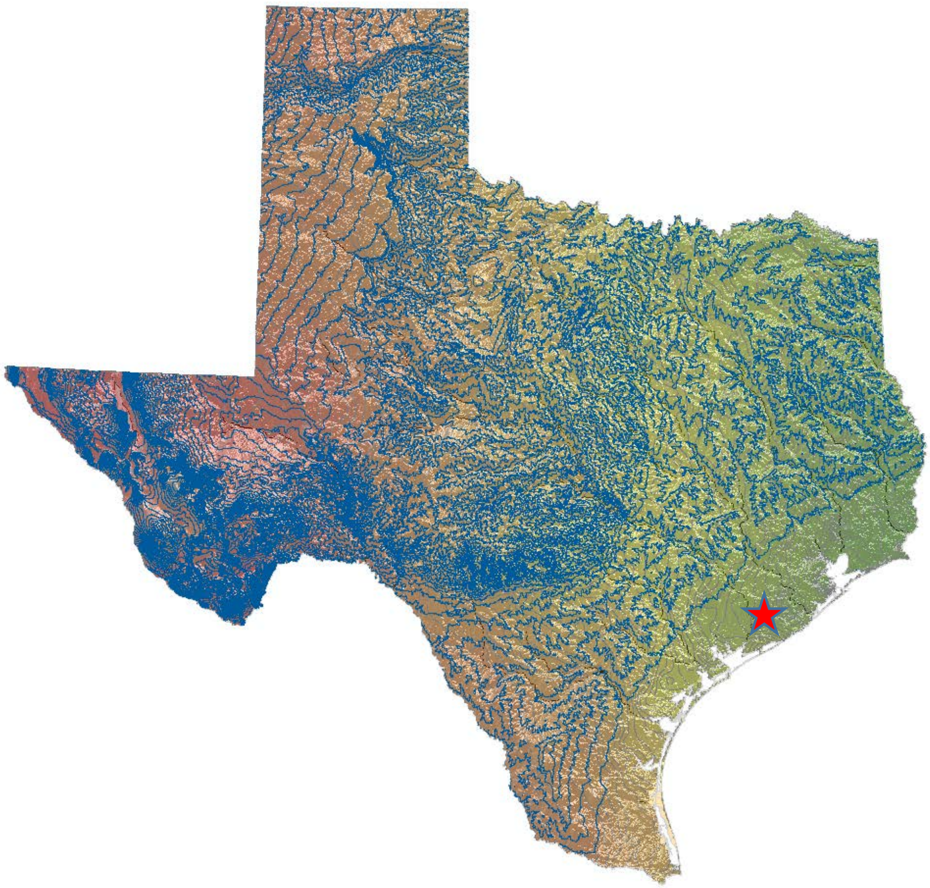
From knowledge prior to this project, which relates to the precipitation map below, Texas's vegetation, in the green/wet area is a forested area with lots of trees. In the yellow/green there is



a lot of agriculture/farms. The farther west the soils are less fertile and dry. They are rangelands (They say the West starts in Fort Worth with it's rodeo.) When you add soil knowledge and vegetation knowledge to precipitation, correlation for runoff begins to come together. In deserts, you get flash flooding when it rain because the land can’t absorb the incoming water fast enough. This is a result of the land being so dry, hard, and lacking of vegetation. West Texas similar to this. There is some vegetation but it is mostly grasses, no woods/forests. Add the desert environment to high elevation changes and this is asking for flash floods and lots off runoff/erosion. As you head back east, in Central Texas, the hill country traps moisture causing higher rainfalls. This also causes a “pocket” of fertile land used for farming. In this area, there will still be a reasonable amount of runoff due to the highs and lows in the topography. However, this is an area with many aquifer recharge zones and the soils are much more permeable than those west so there is more infiltration and less runoff. The further east and southeast you travel towards Louisiana, the shallower the topography and the more fertile the land. There will be much less runoff because there is much more vegetation and the plants soak up the water. The gradient is also low to almost non-existent. This means that there simply isn’t enough force to carry a lot of heavy sediment. In this area, the effect of runoff/erosion will be more like an alluvial fan than a raging rapid.

CONCLUSIONS

In summary, hypsometric properties of high elevation in an area will result in higher runoff and erosion than it will in an area of low elevation. The runoff and erosion will also increase if contributing factors such as dry/impermeable soil, low vegetation, or low precipitation are introduced. The 4 layer map below (same as the one above) has had a star added to it. This is about where the Wharton County, Lane City reservoir is going to be built. If you used my newly made map, you can see that this location is a good location to start looking at. It has low elevation so there won’t be a lot of erosion into the reservoir, it is also in an area that gets a decent amount of rainfall. The land is moist so construction will be easier. The only problem I see with the location, is that it is almost 40miles inland. This is very close for tropical storm/storm surge “backwash” contamination. I would be concerned that something like that might happen.



Reference

Download TCEQ GIS Data. TCEQ, n.d. Web. 2 Dec. 2014.<http://www.tceq.state.tx.us/gis/download-tceq-gis-data>.

Esri. Consbio, n.d. Web. 4 Dec. 2014.<http://ut.maps.arcgis.com/home/item.html?id=5771199a57cc4c29ad9791022acd7f74>.

GID Data Download. TPWD, n.d. Web. 4 Dec. 2014. <http://tpwd.texas.gov/gis/data/>.

Hypsometric Tools. ESRI, n.d. Web. 4 Dec.2014.<http://arcscripts.esri.com/details.asp?dbid=16830>.

Runoff (surface Water Runoff). USGS, n.d. Web. 4 Dec. 2014.<http://water.usgs.gov/edu/runoff.html>.