

Potential Groundwater Contamination from Leachate in Major Texas Aquifers

GEO 327G

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Problem Statement

Landfills are necessary, yet potentially hazardous facilities that are located across the country. Although most modern landfills are well-engineered, the risk of leaching and ultimately groundwater contamination is still present. Leachate is defined as any liquid that drains or 'leaches' from a landfill, and usually contains both dissolved and suspended material. Its composition can widely vary, but is generally caused by precipitation percolating through waste deposited on a landfill. Thus, precipitation is an extremely important factor that could potentially impact leaching rates. The purpose of this study, therefore, is to identify the major Texas aquifers and their sensitivity to leachate contamination using mean annual precipitation data and landfill sites.

The main functions and tools that I will utilize for this project include:

1. **Select by Attributes**
2. **Select by Location**
3. **Exporting shapefile data**
4. **Feature to Raster tool**
5. **Kernel Density tool**
6. **Extract by Mask**
7. **Raster Calculator**

Data Collection

Municipal Solid Waste Sites/Landfills shapefile

<http://www.tceq.state.tx.us/gis/download-tceq-gis-data>

Major Texas Aquifers shapefile

<http://www.twdb.texas.gov/mapping/gisdata.asp>

State of Texas Boundary shapefile

<http://www.landsat.com/texas-free-gis-data.html>

State of Texas Mean Annual Precipitation 1981-2010 shapefile

<http://www.twdb.texas.gov/mapping/gisdata.asp>

Data Preprocessing

All shapefiles already shared the same geographic coordinate system: GCS_North_American_1983. Therefore, no preprocessing was required.

ArcGIS Processing

The landfill site layer contains the locations and other information about all permitted or registered landfills and associated municipal solid waste facilities for the state of Texas. For this study, I am only concerned with open landfill sites that are within the boundary of any major Texas aquifer.

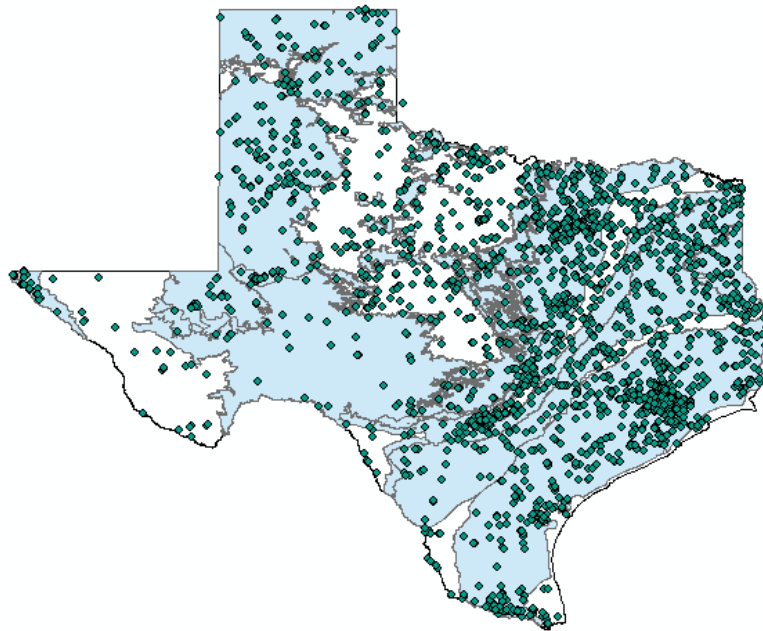


Figure 1: All registered landfill sites within the state of Texas.

Therefore, by using 'Select by Location,' I first identify the landfill sites that are within the major aquifer boundaries and remove the sites that are not.

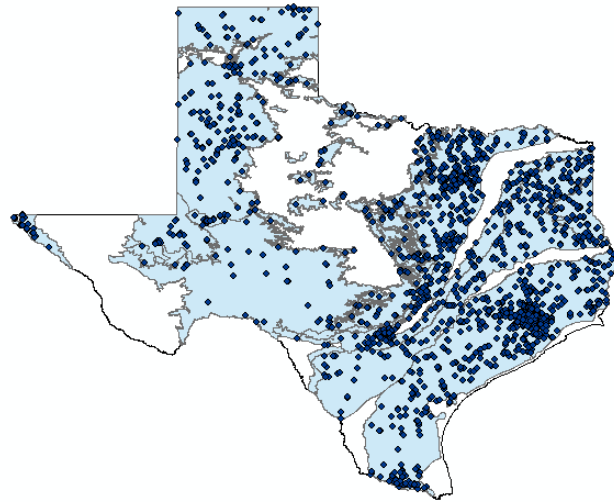
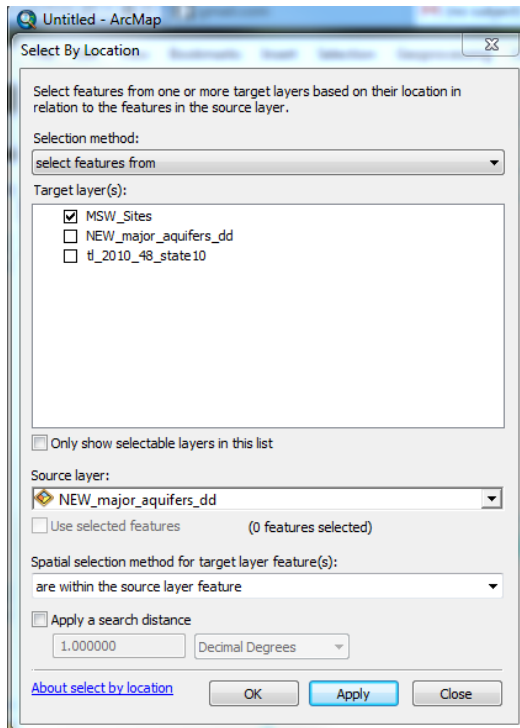


Figure 2. Landfill sites within boundaries of major Texas aquifers.

However, some of the landfill sites are inactive or closed. For this study, I am only interested in landfills that are currently active and open. Therefore, I used 'Select by Attributes' to determine which landfills are currently active.

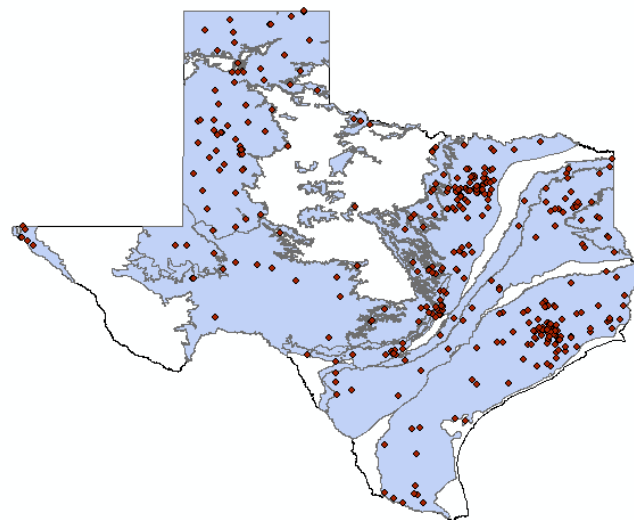
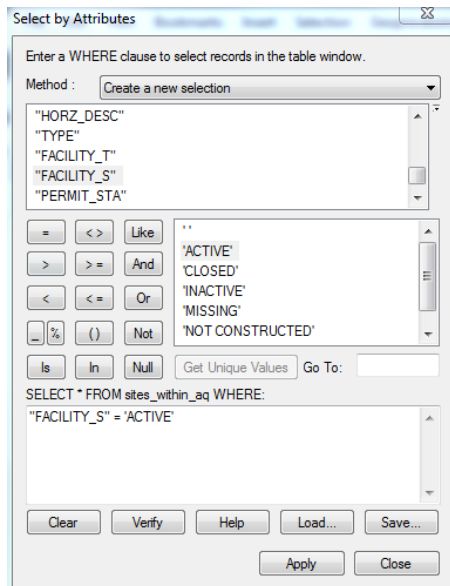


Figure 3: Landfill sites that are currently active.

Next, in order to distinguish the different aquifers within Texas, I changed the symbology according to the aquifer name, and selected a color scheme to differentiate them.

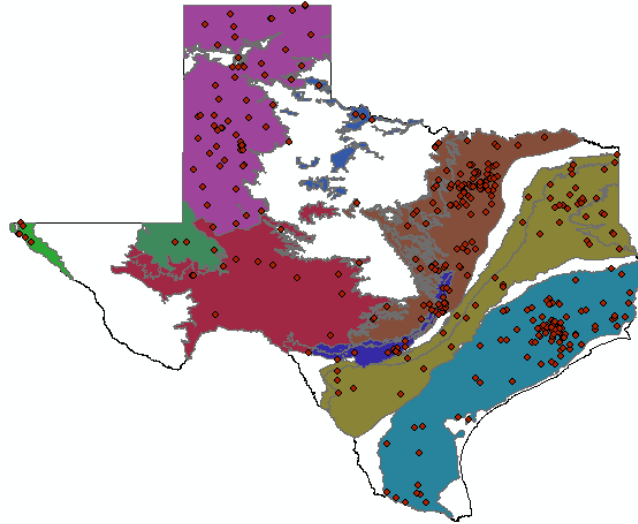


Figure 3: Major aquifers in Texas.

Next, I added the precipitation shapefile for the state of Texas. In order to see the precipitation data on a regional basis, I changed the classification and symbology of the shapefile.

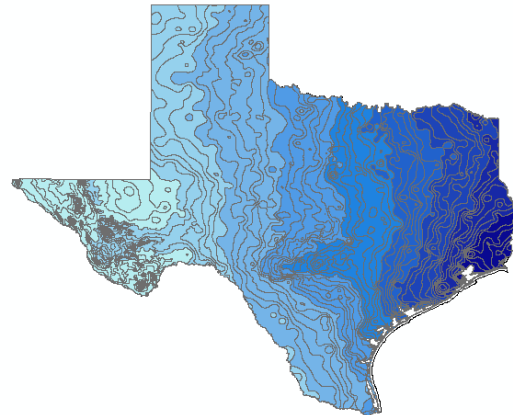
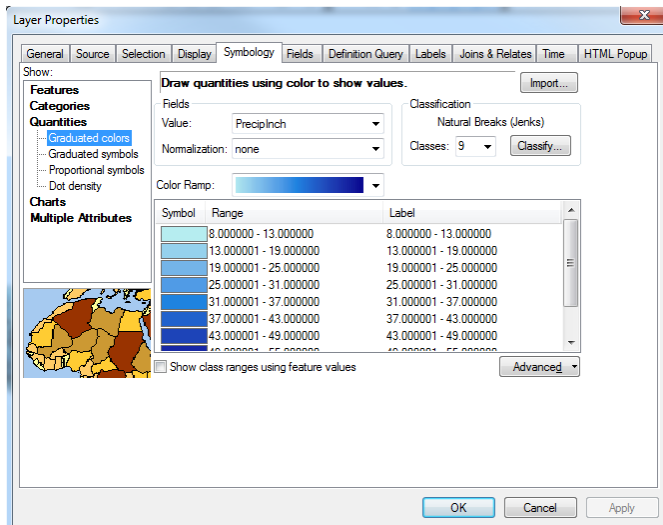


Figure 4: Re-classification of mean annual precipitation data for Texas.

Next, in order to view the precipitation data as a continuous field of data, I used the 'Feature to Raster' tool to convert the precipitation shapefile to a raster file.

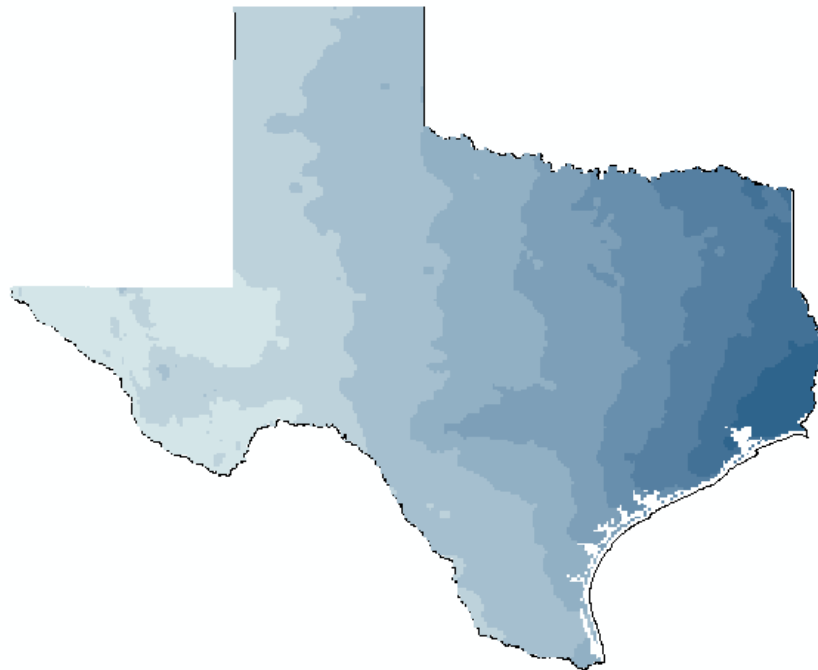
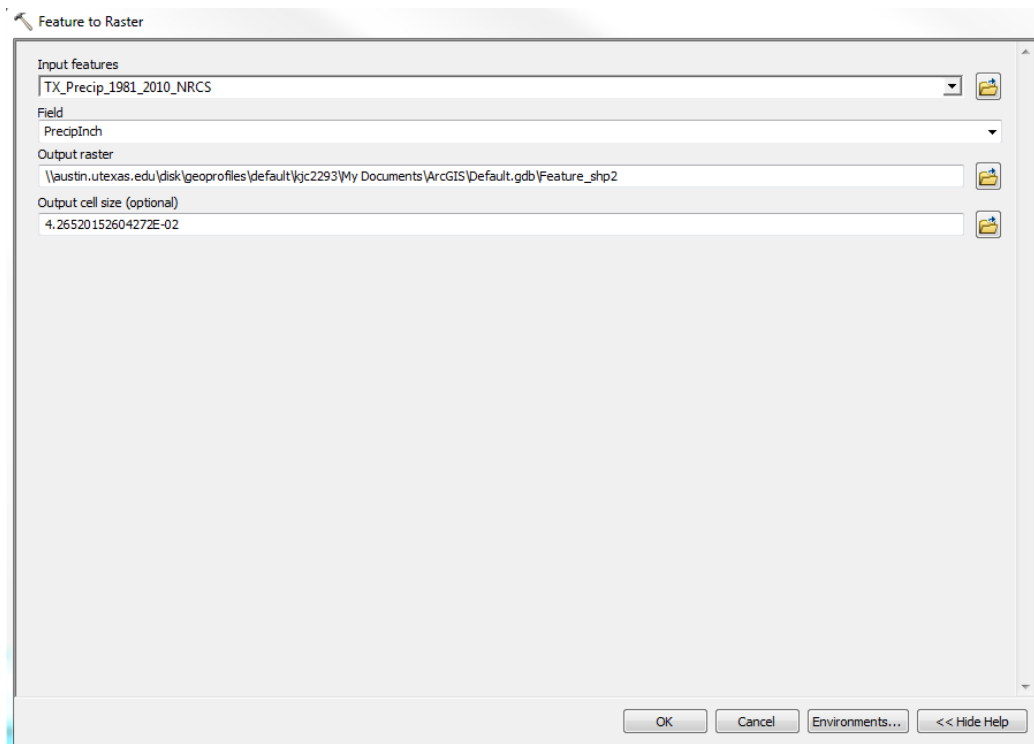


Figure 5: Precipitation feature class to Raster and output.

By assuming that a greater leaching risk is associated with a greater number of landfills, I needed to calculate the density of the landfill sites. To do this I used the Kernel Density tool. For the Population field, I chose to select 'NONE.' Therefore, each feature will be counted once when the Kernel Density tool runs.

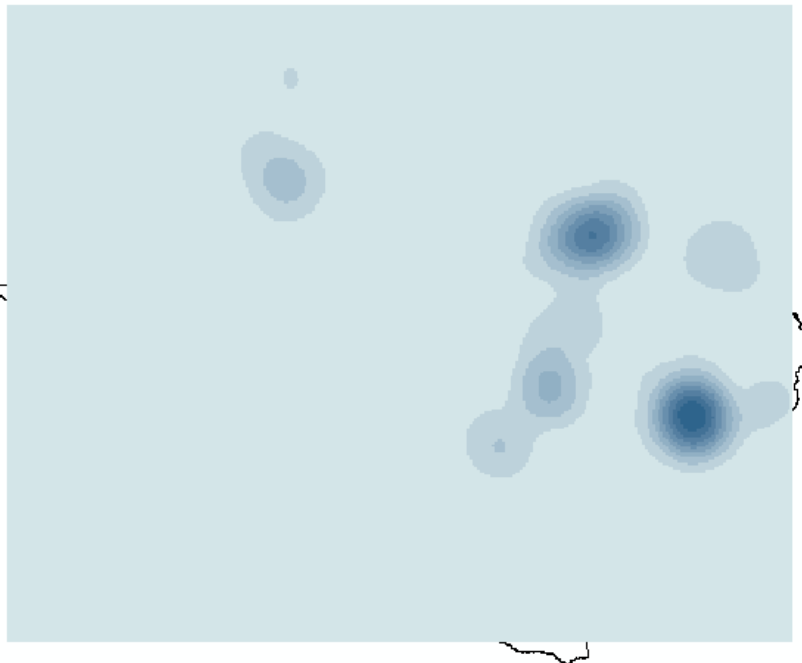
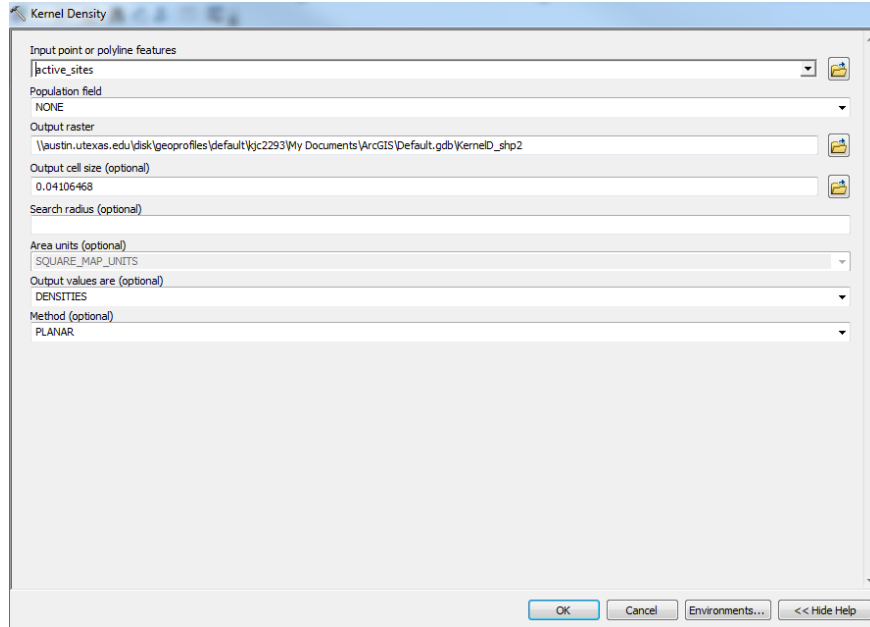


Figure 6: Using Kernel Density tool to show density of active landfill sites.

The Kernel Density tool produced a light blue box where my data does not extend. Therefore, I used the 'Extract by Mask' tool to clip the Kernel Density output to the Texas boundary shapefile.

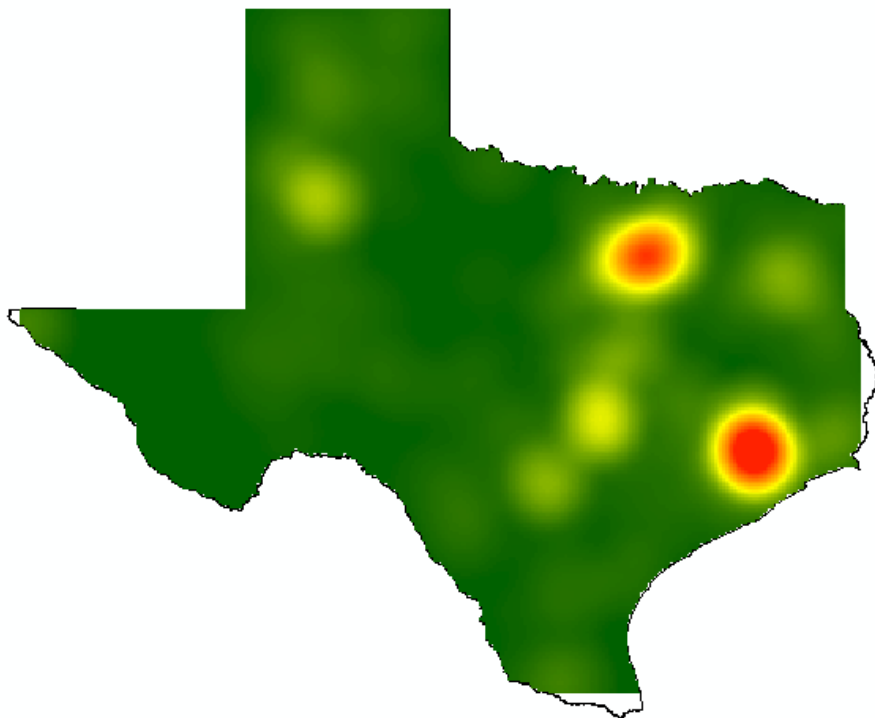
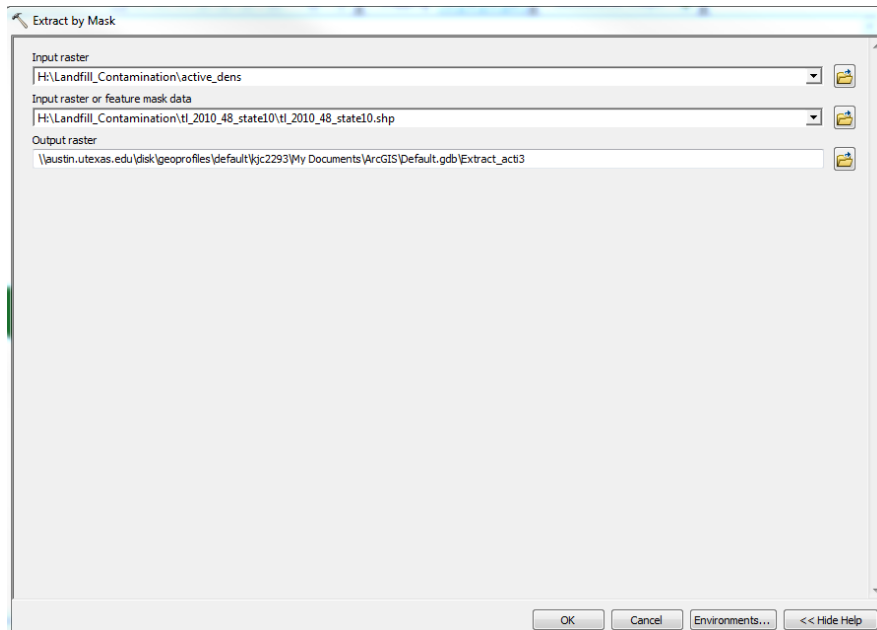


Figure 7: Extract by Mask and color change for active landfill sites

In order to determine areas with highest density of landfills as well as areas of highest annual precipitation, I utilized Raster Calculator by adding the Precipitation and Site Density raster layers.

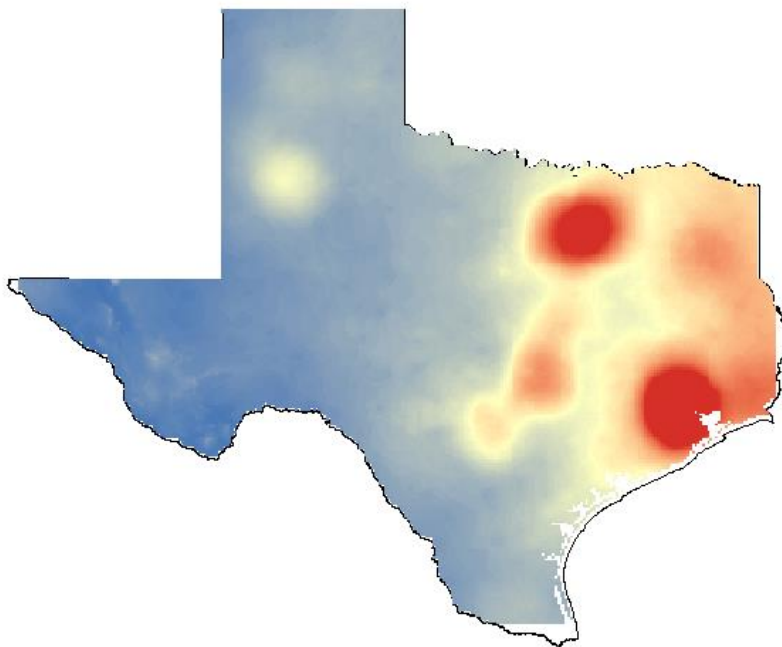
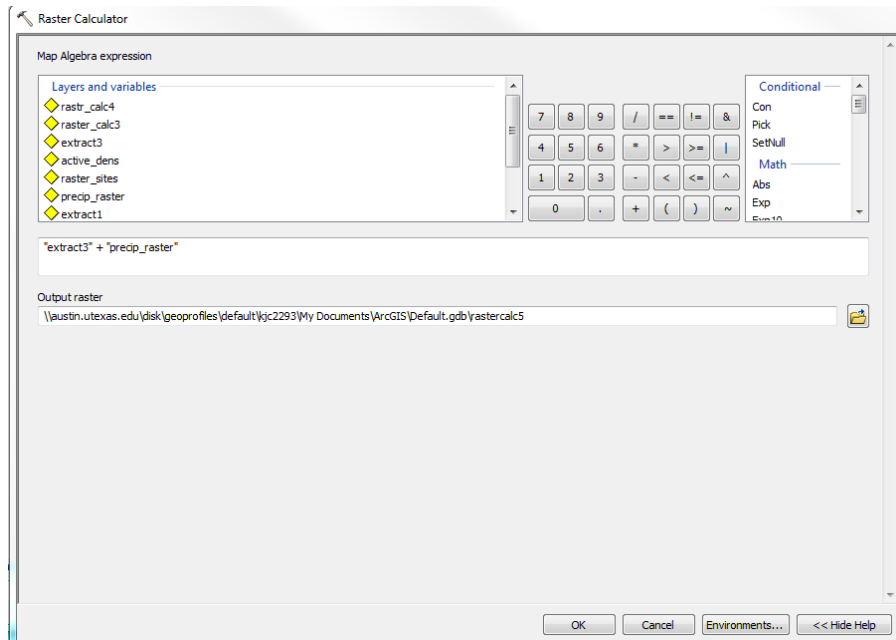


Figure 8: Raster calculator and output displaying greatest precipitation and landfill site density. Areas in red represent locations that have the highest site density and annual rainfall.

Although the combined raster layer for annual precipitation and site density looks very similar to the original site density layer (Figure 7), it is clear that the areas with highest precipitation and greatest landfill site density are at the greatest risk for groundwater contamination by leaching.

Now, I would like to see which major aquifers could be most affected by potential leachate. To do so, I added the major aquifers back to the map and set increased its transparency.

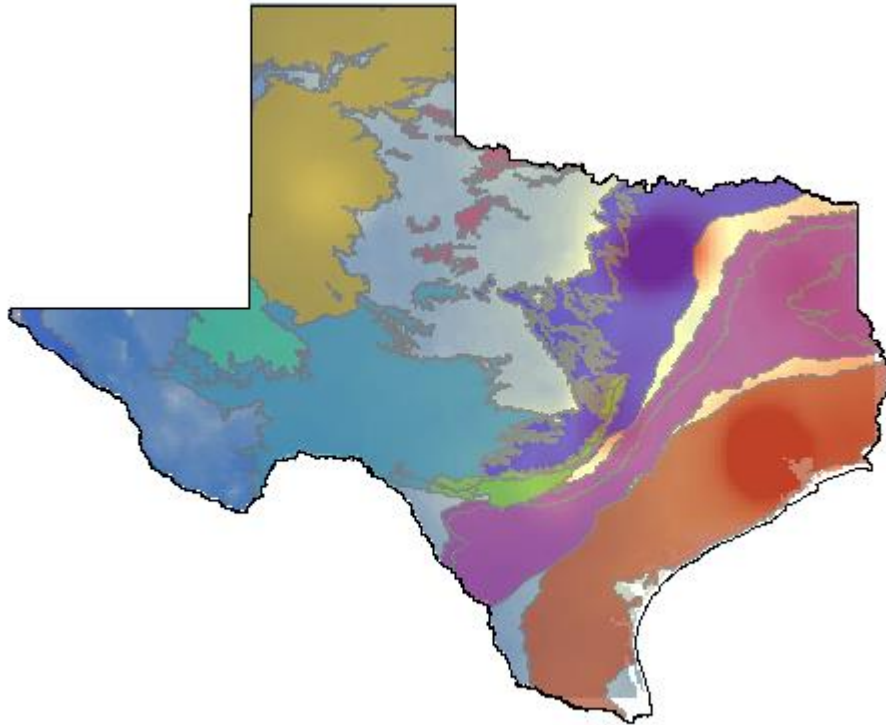


Figure 9: Major Texas aquifers and their likelihood to experience leaching contamination.

Final Data Presentation

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