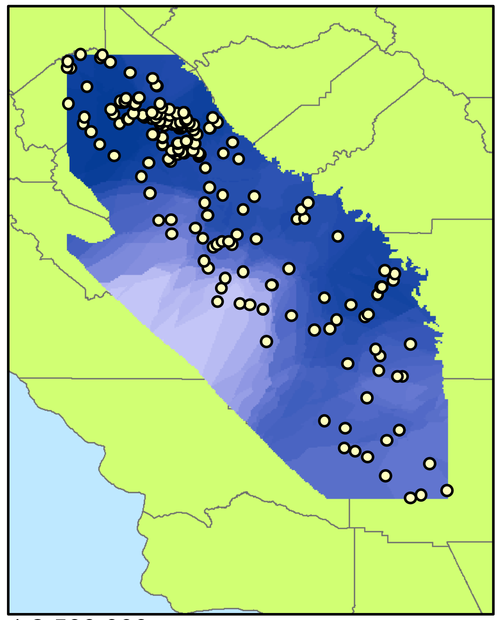
Travis Davis
GEO 327G
12/7/2017

San Joaquin Valley Water Level Depth Changes for 1980-1990 and 1990-2000

1980



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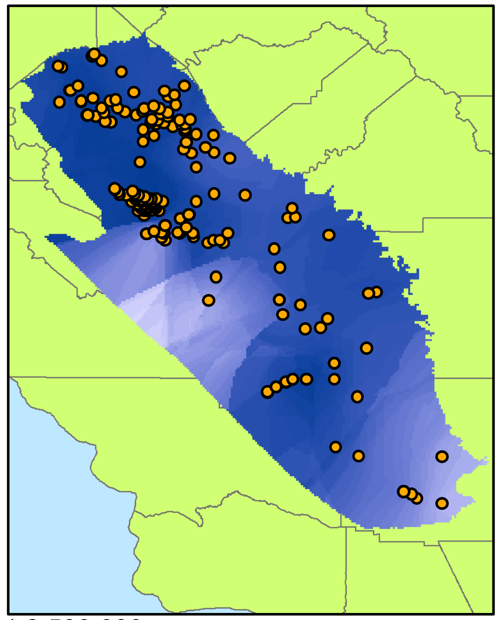
1990



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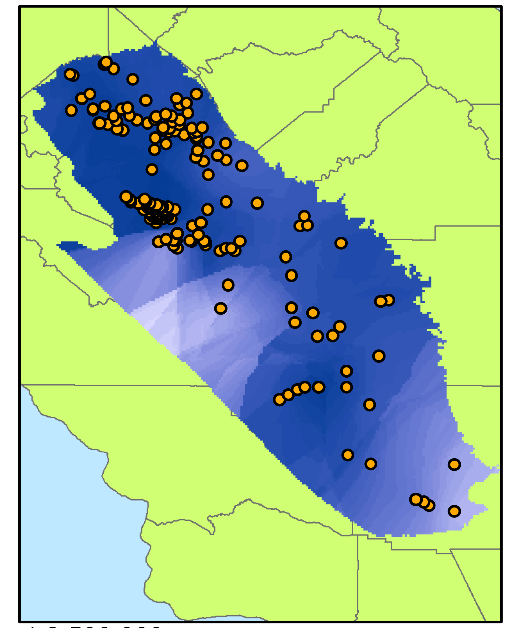
Initial Decade Measurements

- 1980 Well Locations
- 1990 Well Locations
- 2000 Well Locations

Depth to Water Table

- <5
- 5-10
- 10-20
- 20-30
- 30-40
- 40-50
- 50-60
- 60-70
- 70-80
- 80-90
- 90-100
- 100-110
- 110-120
- 120-130
- 130-140
- 140-150
- 150-165
- 165-180
- 180-195
- 195-210
- 210-225
- 225-240
- 240-255
- 255-270
- 270-285
- 285-300
- 300-315
- 315-330
- 330-345
- 345-360
- 360-375
- 375-390

1990



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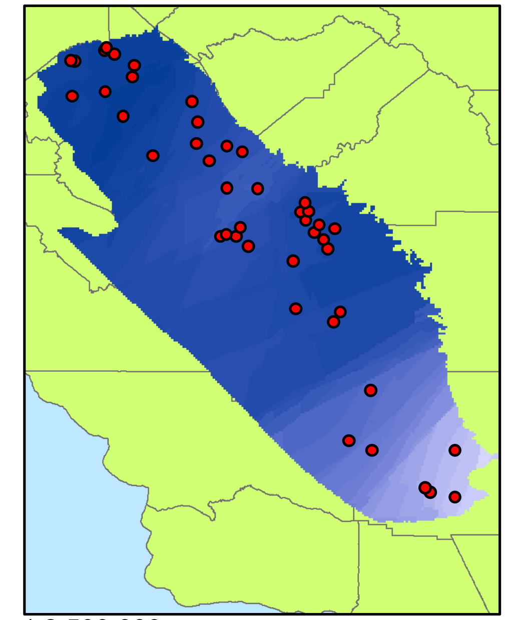
2000



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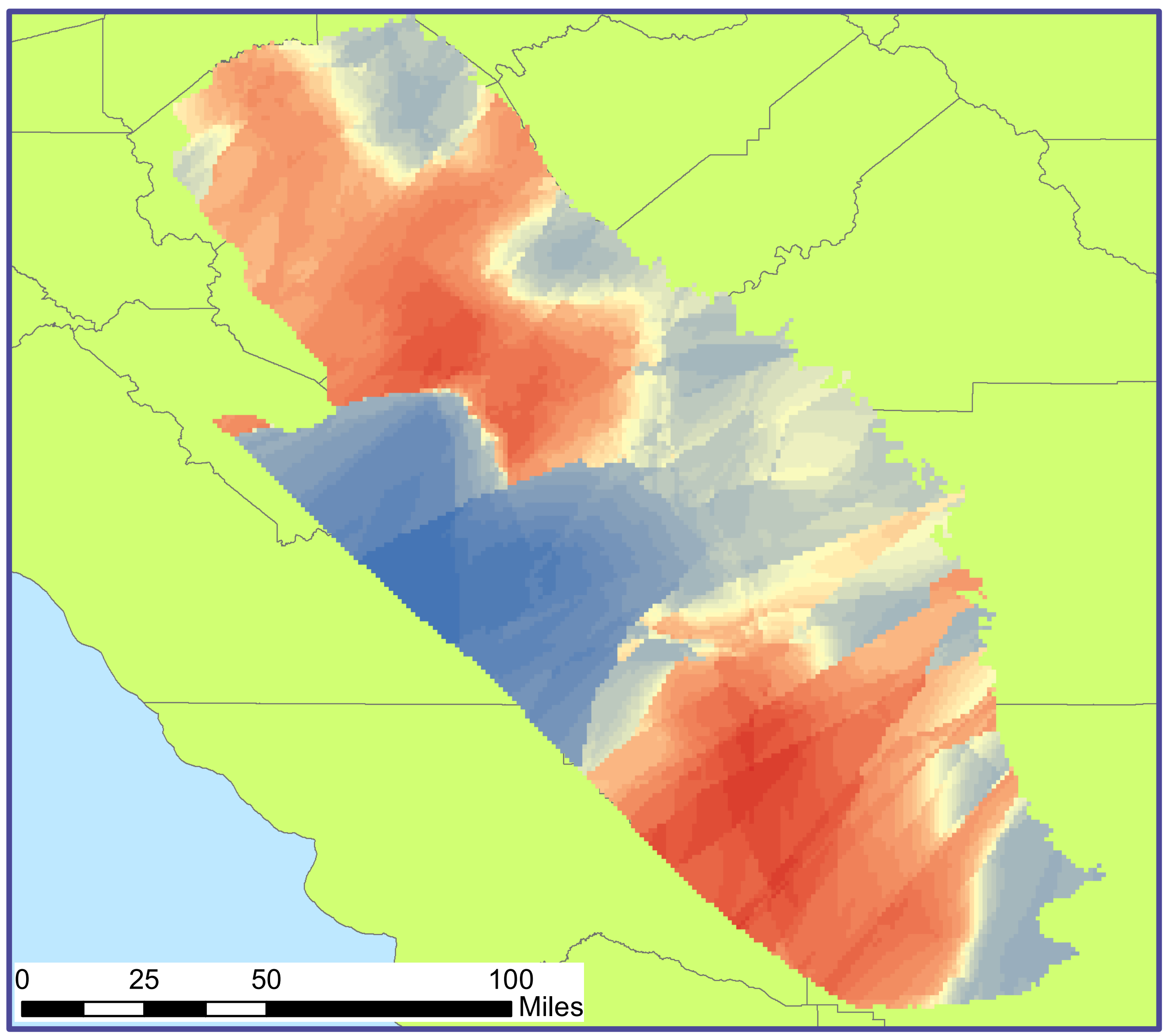
1980-1990



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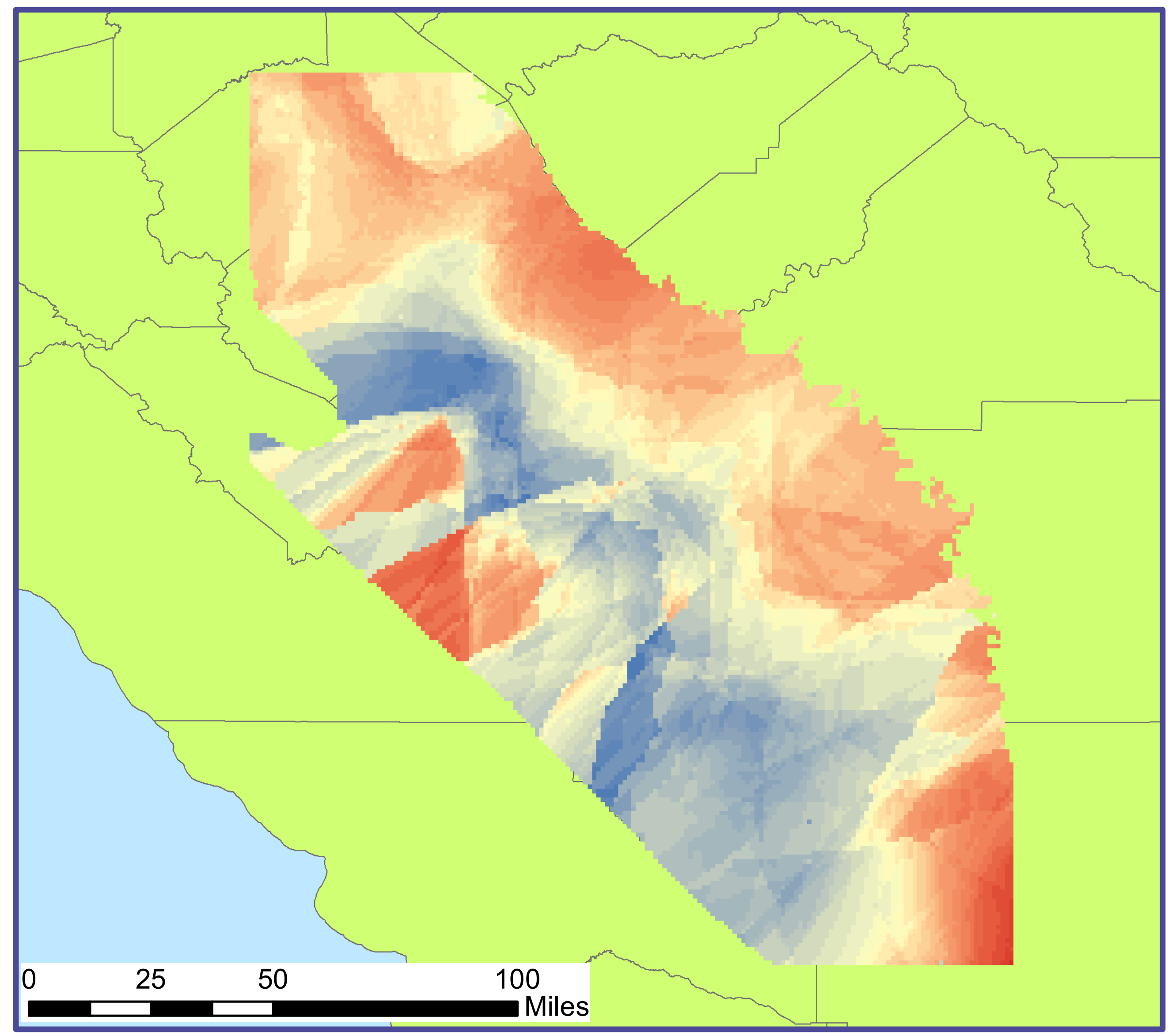
Decade Differences in Water Level Depth (ft)

1980-1990	1990-2000
160-170	250-300
150-160	200-250
140-150	170-200
130-140	140-170
120-130	110-140
110-120	80-110
100-110	60-80
90-100	40-60
80-90	20-40
70-80	15-20
60-70	10-15
50-60	8-10
40-50	6-8
30-40	4-6
20-30	2-4
15-20	0-2
10-15	-2-0
5-10	-4--2
0-5	-6--4
-5-0	-8--6
-10--5	-10--8
-15--10	-15--10
-20--15	-20--15
-30--20	-30--20
-40--30	-40--30
-50--40	-50--40
-60--50	-60--50
-70--60	-70--60
-90--70	-80--70
-110--90	-90--80
-122--110	-110--90
<-122	<-110

1990-2000



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GCS North American 1983

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Dr. Helper

GEO 327G

7 December, 2017

San Joaquin Valley Water Level Differences between 1980-1990 and 1990-2000

Introduction

The San Joaquin Valley in California has undergone extensive groundwater withdrawal over the 20th century to present. The amount of pumping decreased in the 1960's due to programs implemented to import surface water from other areas. From this point on, the amount of groundwater extraction was influenced by several drought periods from 1976-77, 1986-92, and 2007-09, which increased pumping to meet the agricultural needs of the valley.

Depth to water level data was collected for the years 1980, 1990, and 2000. The drought period in the late 80's is one of the main focuses of this project, and observing how the water levels changed as a result of the drought, and how much the water levels were able to recover by the year 2000.

Data Collection

The data used was collected from the USGS website shown in Figure 1.

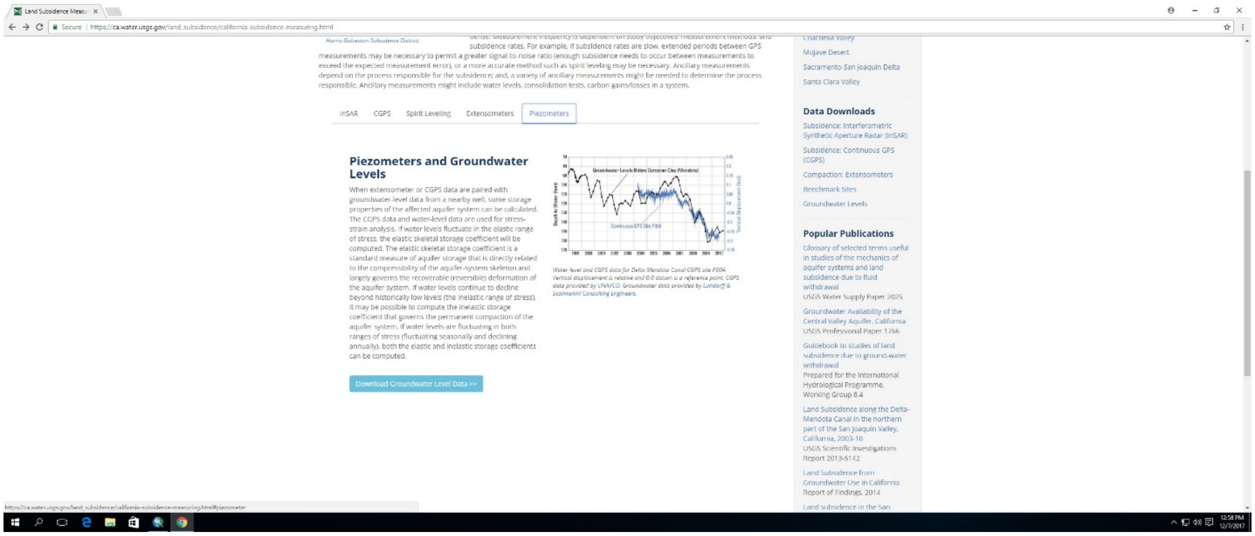

Figure 1. USGS website.

This was the first step in the data collecting. Extensometer data for groundwater gathered through this link, which was the data collecting options page, shown in Figure 2.

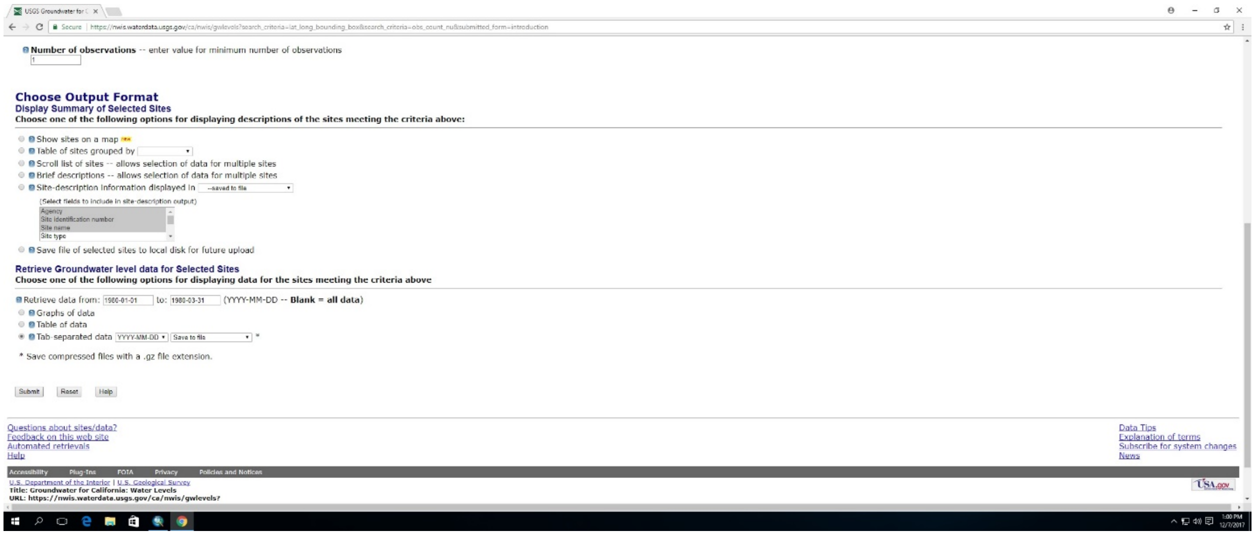

Figure 2. Data collection in the forms of water table depth and latitude and longitude.

Figure 2 shows where the data for the groundwater levels and locations of the wells (in latitude and longitude) was gathered. To attempt to get consistent data for different decades, I selected an interval of months for 1960, 70, 80, 90, 2000, 2010, and 2016. The data was downloaded in a non-ideal way. The first search yielded the wells used in the extent of the valley and their location in latitude and longitude. The second search yielded each groundwater level measurement for a span of 3 months in each decade. For some reason, the wells that were listed as being used did not all have water level data. Each well had to be gone through to find and delete the ones that didn't have water level data. After compiling all the needed data into one excel file for each year, (shown in Figure 3 is the excel file for 1990) the file was converted to a CSV file and exported to ArcMap.

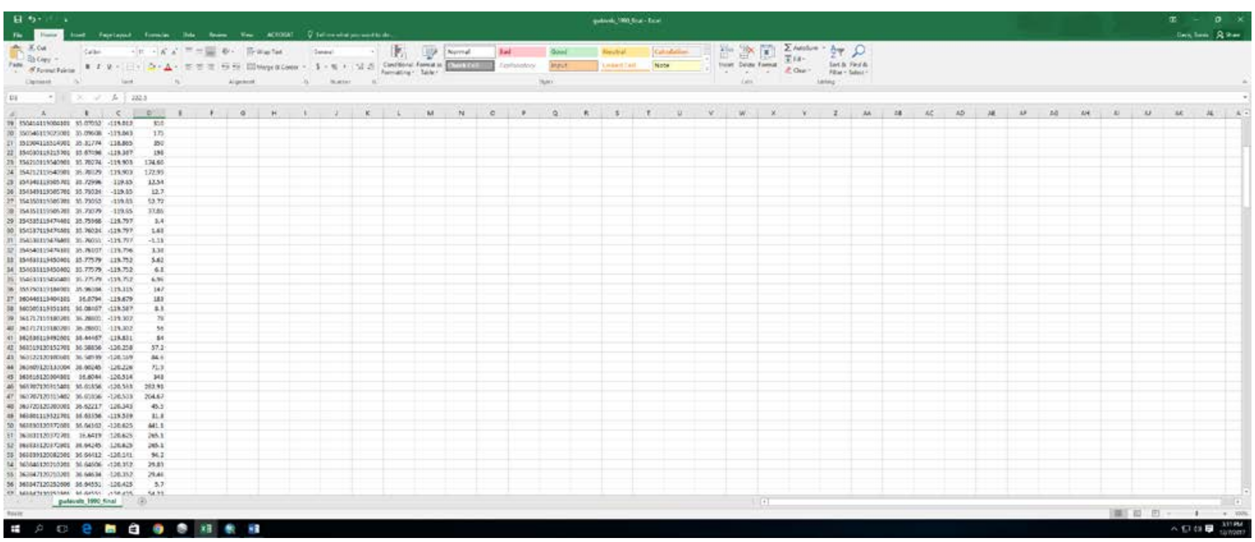
Figure 3. Final excel file with water depth data and location for one 1990.

This was the final product for the year of 1990. The file was converted to a CSV file to export into ArcMap.

Data Preprocessing

Once the data was in ArcMap, it was exported in the form of a text file. After that, the X,Y data was added for the file, which put the wells on the map with their water level values. From there, the text file was converted into a shapefile. This process was done for each year. The end product is shown in Figure 4.

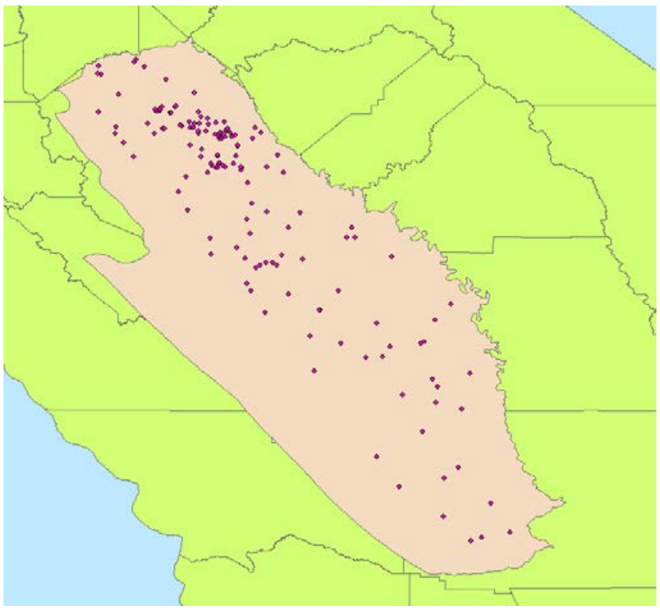

Figure 4. Shapefile for 1980 measurements.

Attempts to match up data for the same wells in the different years is shown in Figure 5. After deleting all the wells that weren't repeated over the years, there ended up being only 10 wells that were there for every year, and none of them were actually located in the San Joaquin Valley. So this method was abandoned and the decision was made to just take all the well data for each year and work from there, which would provide more data, but also result in some problems with showing the differences between water level data over the years for areas that one year didn't have measurements for, but the other year did.

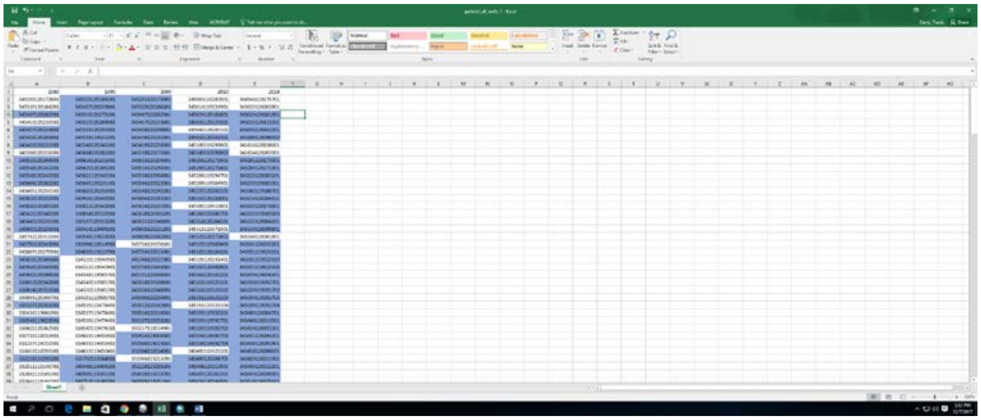

Figure 5. Attempt to gather same well measurements over the years.

Due to the lack of data for the years 2010 and 2016, the data was left off the map. Instead the years 1980, 1990, and 2000 were the main focus, which had the best data as far as amount and similar locations for wells. This is shown in Figure 6.

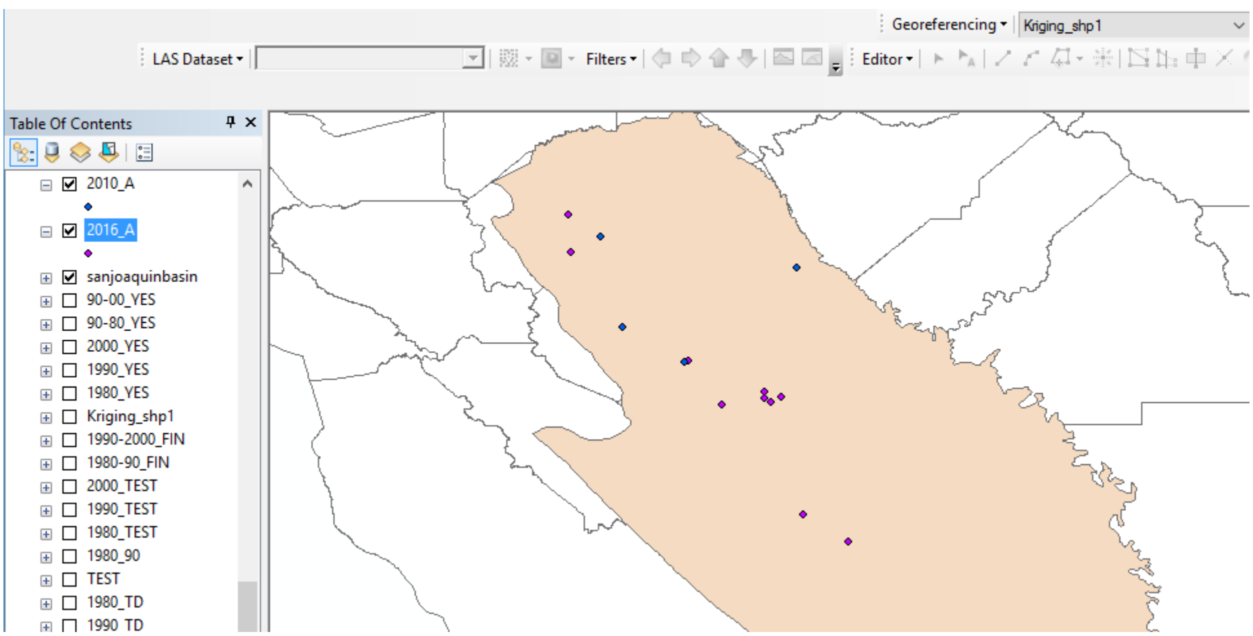

Figure 6. 2010 and 2016 total wells measured.

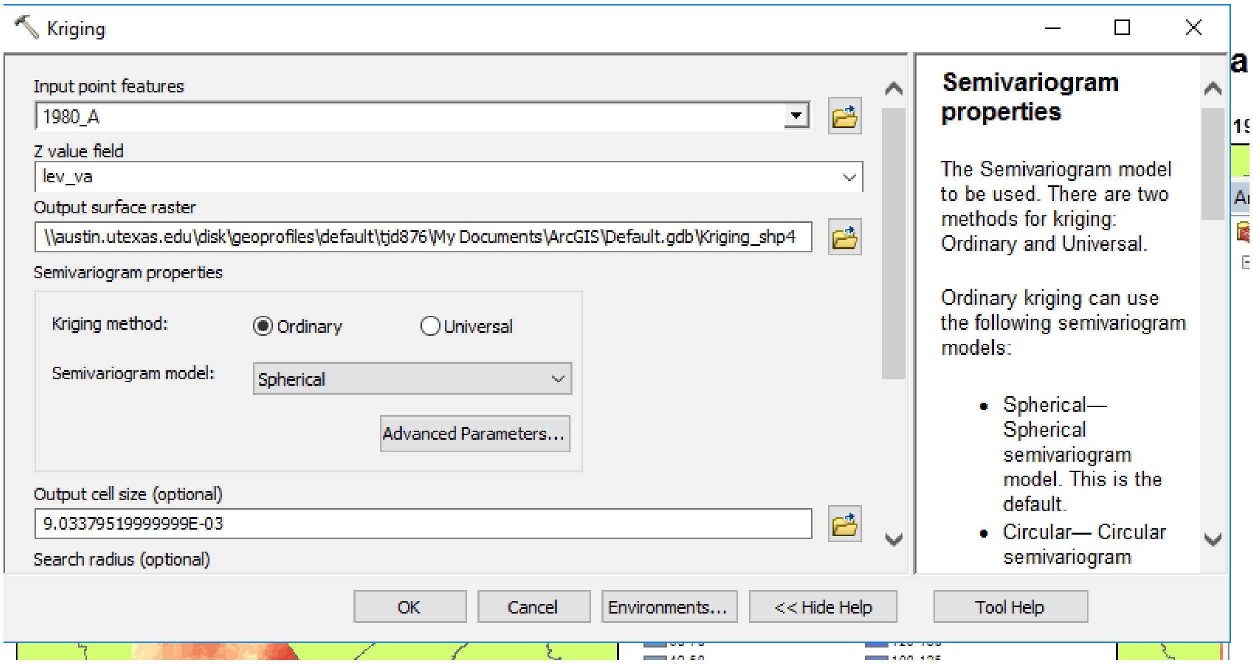

Figure 7. Kriging tool.

After testing the different interpolation methods, Kriging proved to be the most effective. This tool was used to convert each of the measurements in the form of point features into a surface raster.

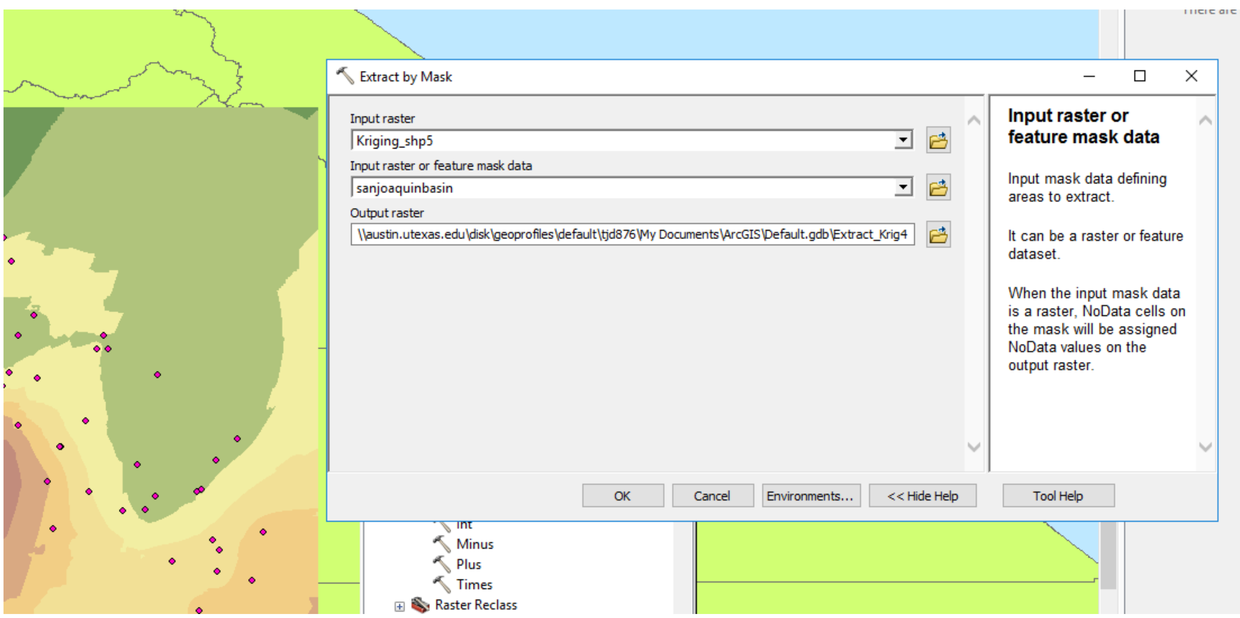

Figure 8. Extract by mask tool.

After the raster surface was created, the extent of it was limited to the San Joaquin Basin with the Extract by mask tool. This process is shown in Figure 8.

The next step was to define the intervals to most effectively show the distribution of water depth data. This process is shown in Figure 9.

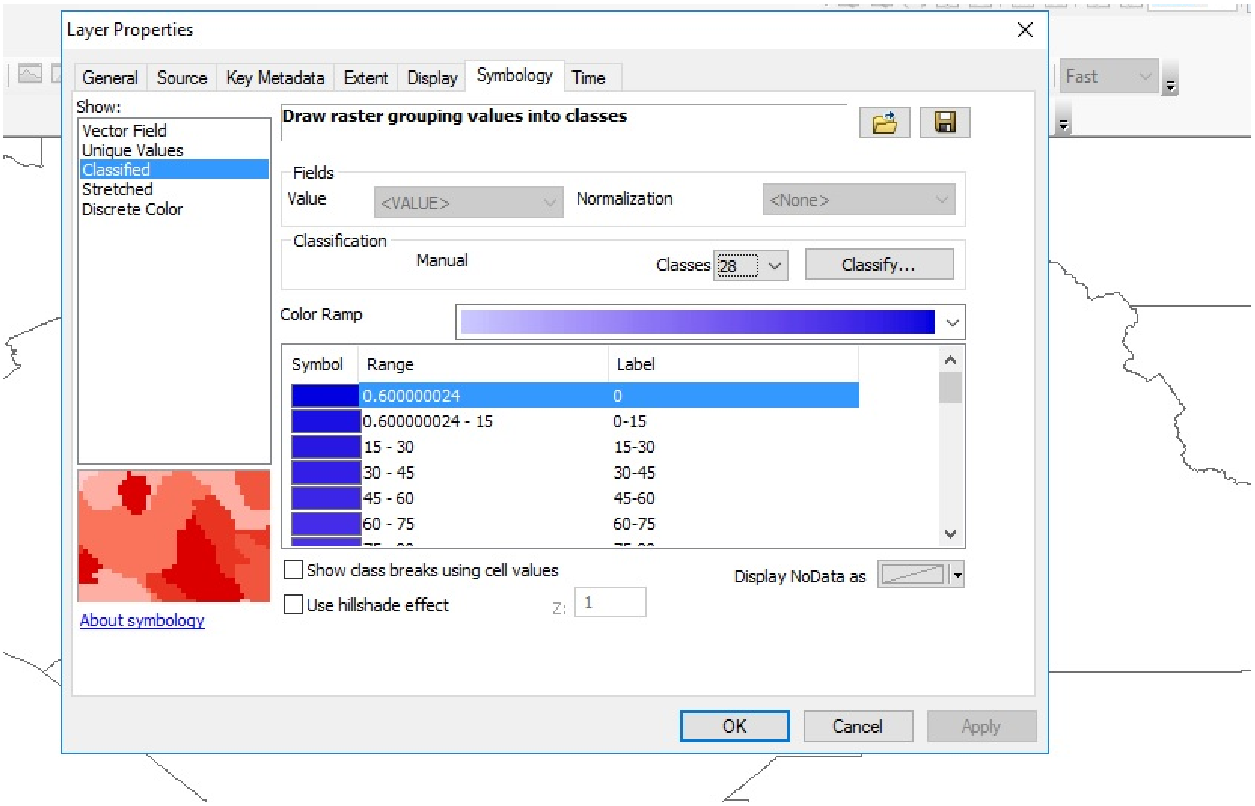

Figure 9. Defining intervals for water depth.

This was the process for defining the depth to water level intervals for a certain year. After classes were formed with intervals of 15 feet, the organizing for each of the raster surface properties was done, yielding the end product for the particular year. One of the three end products is shown in Figure 10.

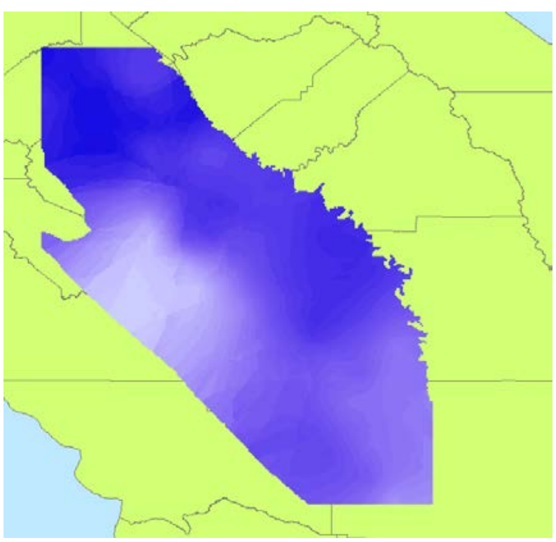

Figure 10. End result of raster surface for water depth.

The next step was to create a raster of the difference between water levels for the years 1980-90 and 1990-2000. This was done with the raster calculator shown in Figure 11.

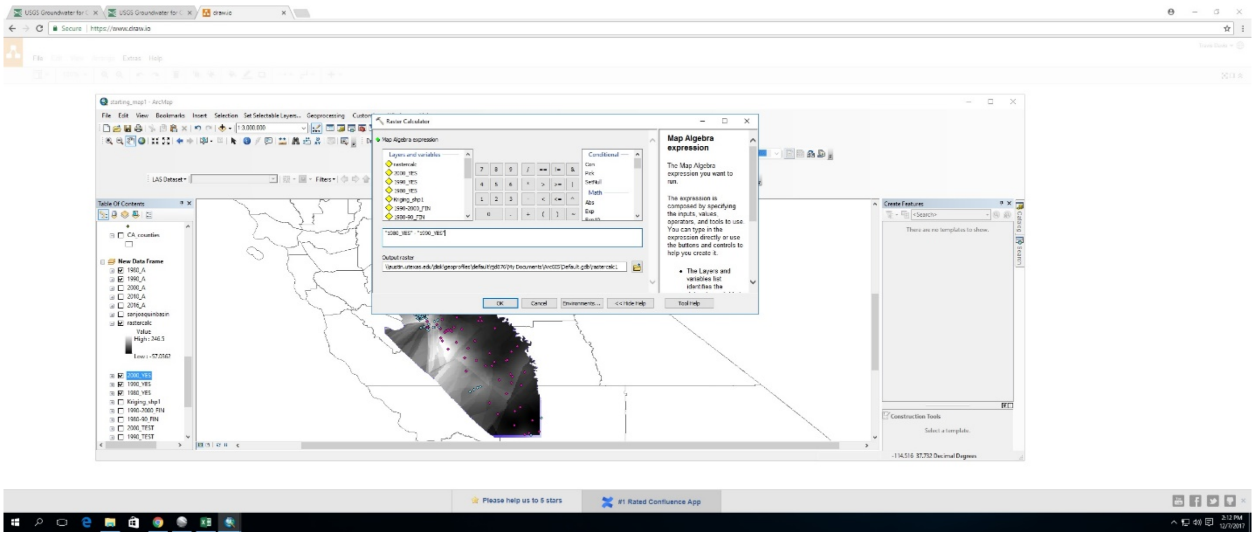

Figure 11. Raster calculator for different decades.

This was the process was showing the difference between water levels between decades.

The next step was to define the intervals which most effectively showed the actual differences between measurements, and an attempt to limit the influence of the outlying calculations. This step is shown in Figure 12.

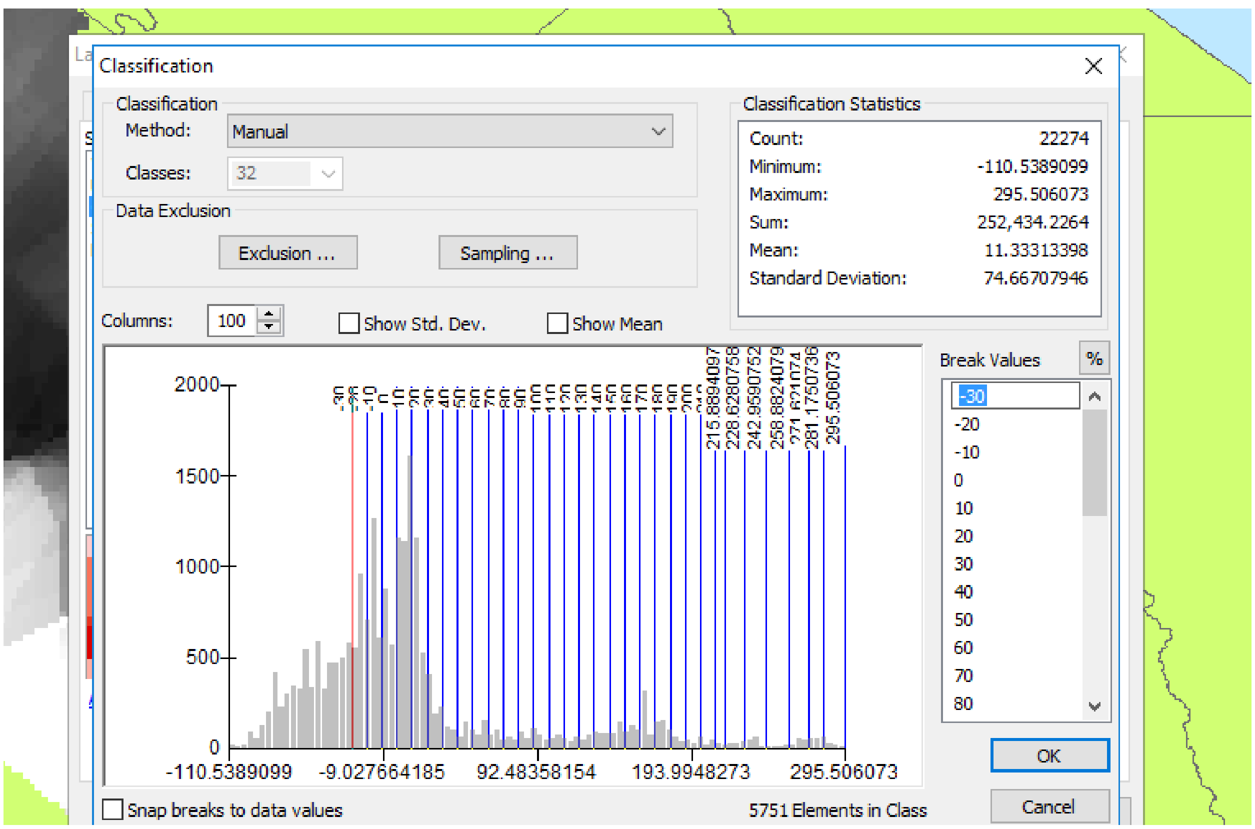

Figure 12. Raster interval manipulation.

Figure 12 shows the process of manipulating the intervals of the water level difference between decades. Due to outliers that didn't have close enough data to a measurement for one year, the "difference" between years were inaccurate for some measurements, yielding much bigger rises in water level due to the absence of data for one year having a default value of 0 feet to water level depth. To offset these outliers and focus more on the distribution for realistic comparisons, the intervals were separated into small intervals for the lower values, since these are the most accurate. These small values are the most accurate because it shows the difference for water levels for an area between decades as close to 0, which means that there were close wells nearby for both decade.

After formatting the data, the end product was produced and is shown in Figure 13.

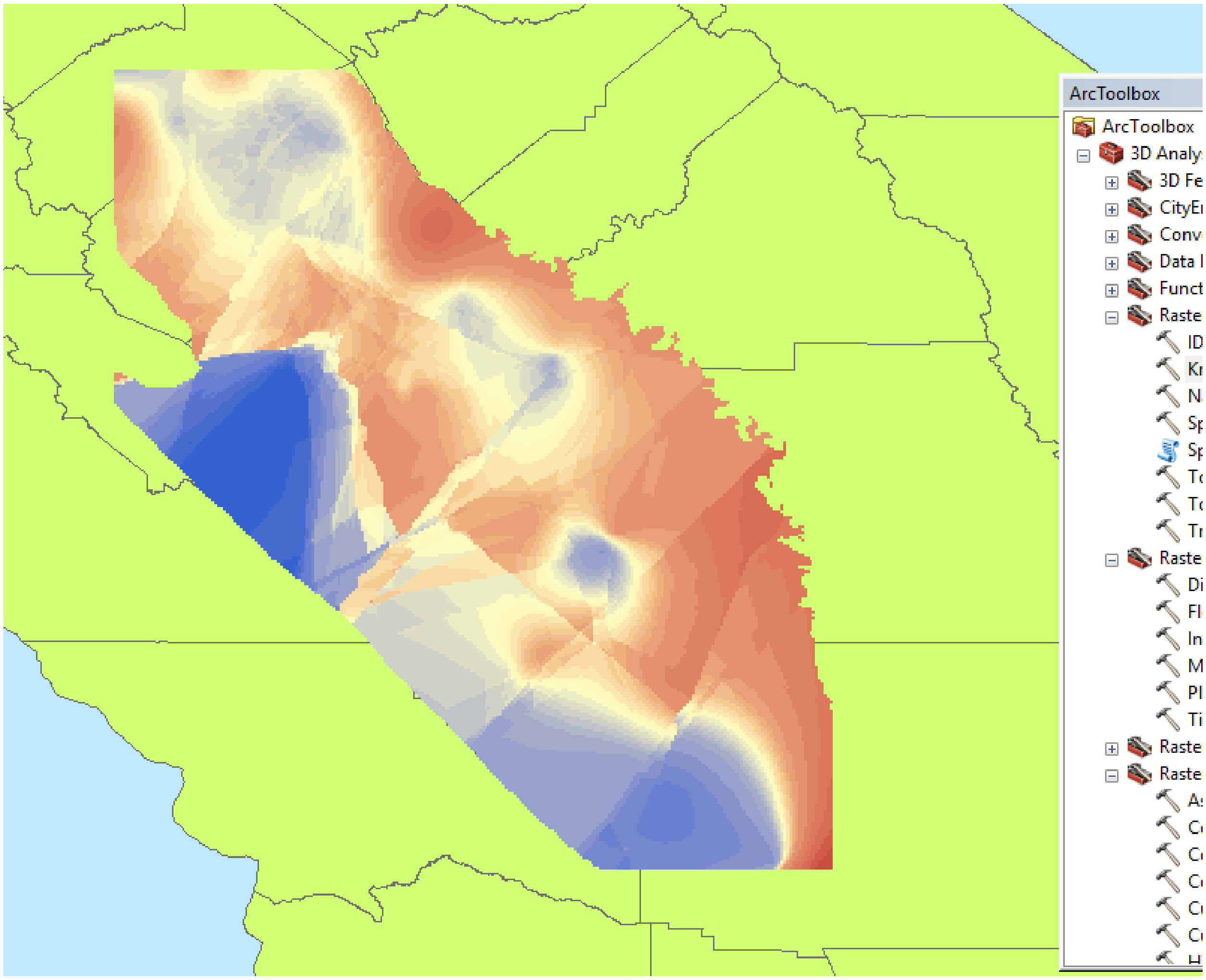

Figure 13. End product for "difference" raster surface.

ArcGIS Processing

The raster surface data for each of the three years was gathered from the classification of each layer. This data is shown in Figures 14, 15, and 16.

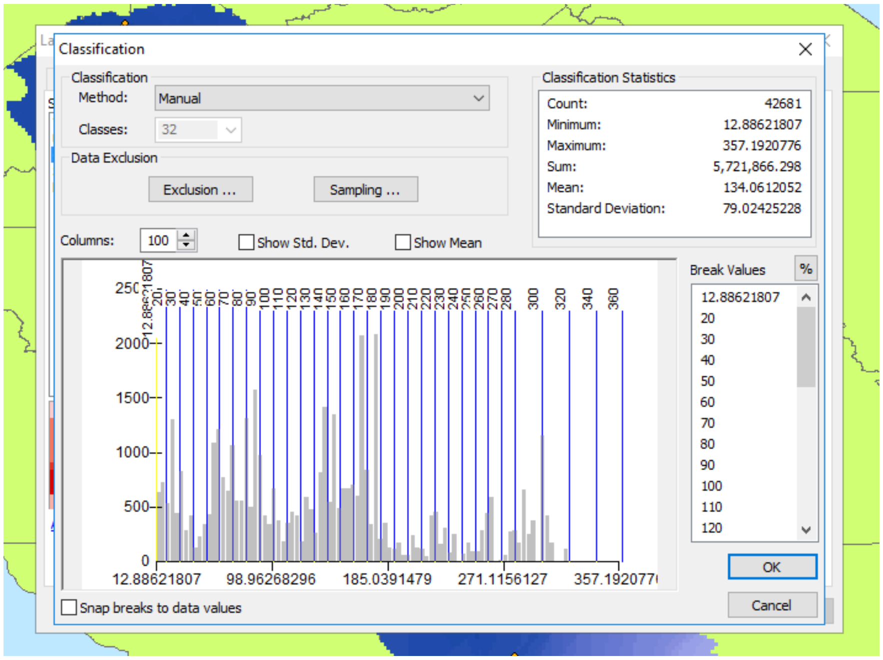

Figure 14. Classification of data for 1980 raster surface.

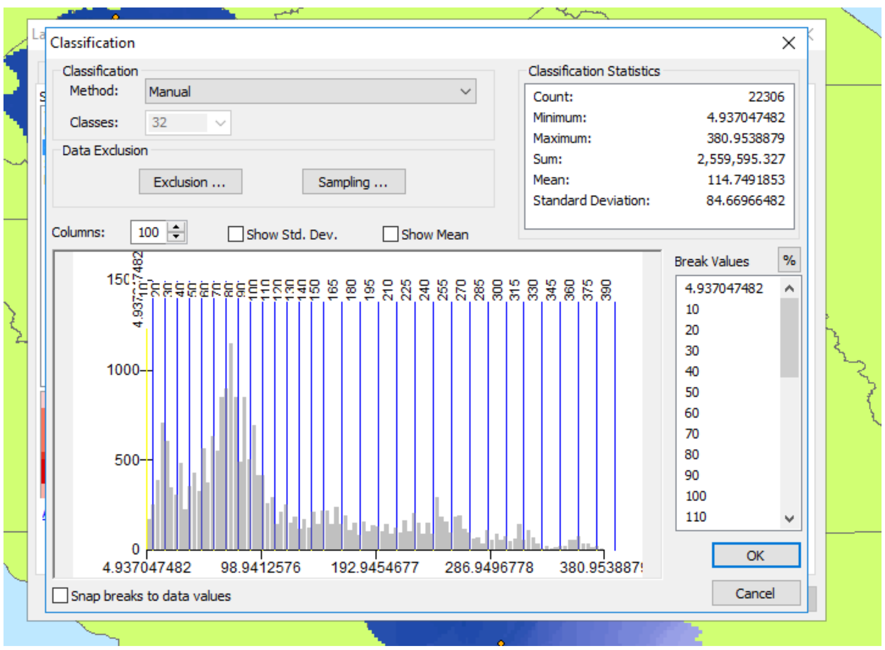

Figure 15. Classification of data for 1990 raster surface.

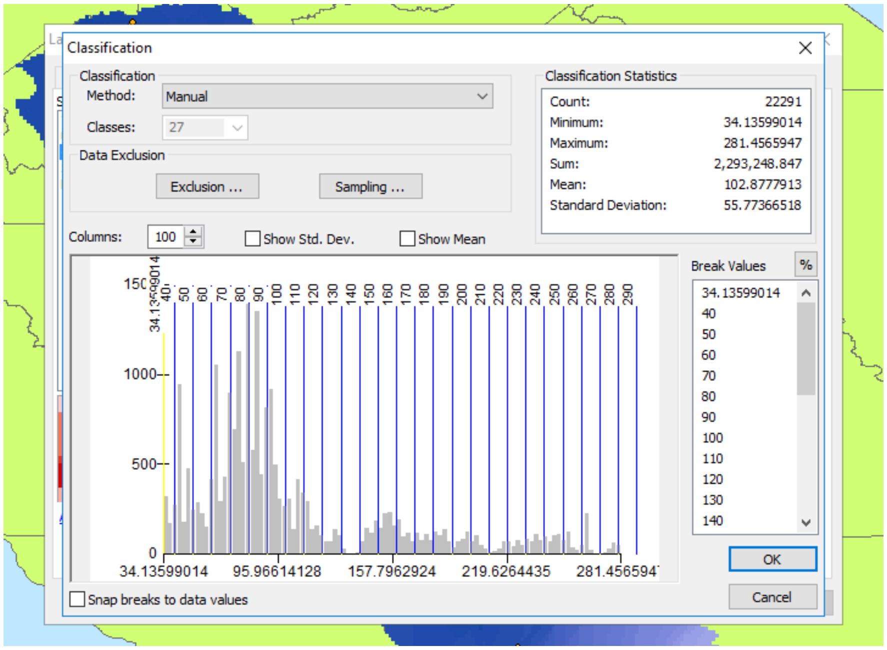

Figure 16. Classification of data for 2000 raster surface.

To easily see the differences between the data, Table 1 is shown below.

Year	**Mean Water Table Depth (ft)**
1980	134.06
1990	114.74
2000	102.87

Table 1. Mean water table depth for 1980, 1990, and 2000.

As shown from Table 1, the depth to the water table has decreased between each of the years. Further confirmation of this data is shown with the difference between decades classification layers, in Figures 17 and 18.

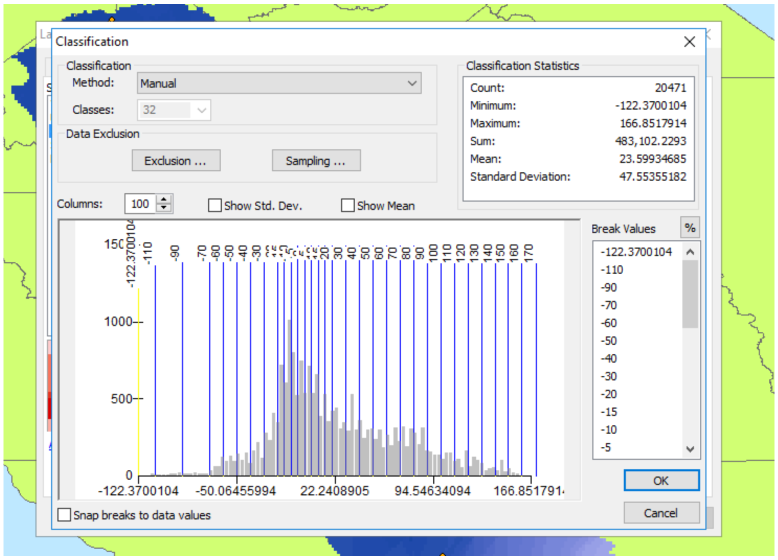

Figure 17. Classification of data for 1980-1990 difference raster surface.

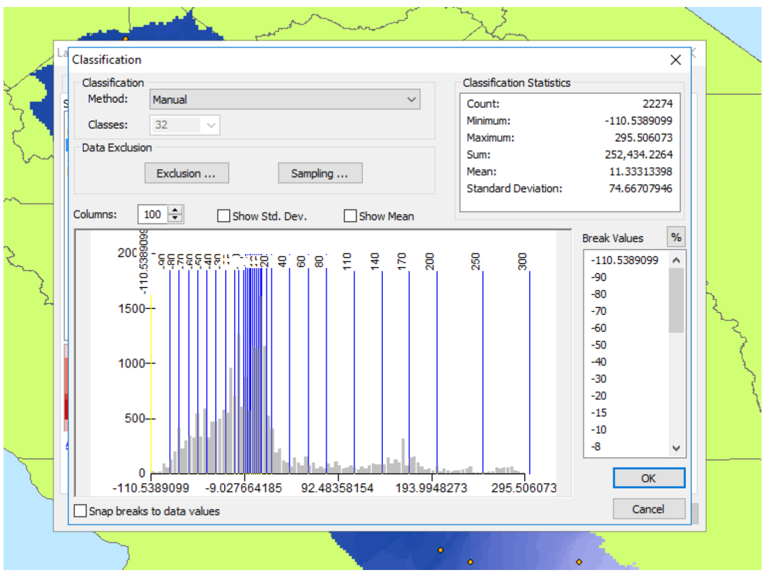

Figure 18. Classification of data for 1990-2000 difference raster surface.

A table comparing values for the two difference in year's data is shown below.

Years	**Mean Change of Water Table Depth (ft)**
1980-1990	Rise of 23.60
1990-2000	Rise of 11.33

Table 2. Mean water table depth difference between 1980-1990 and 1990-2000.

As Table 2 shows, the water table relative to the surface has been rising from 1980 to 2000.

Conclusion

As the data has shown, the depth to the water table has decreased in the years from 1980 to 2000. This does not reflect completely represent the water table fluctuations with time because water levels rise and fall constantly. There was not enough data to get a very accurate assessment of the regional water levels, which resulted in misrepresentations of areas that had no data, and was purely raster interpolation method. Obviously, the best way to represent water levels on the regional scale in the San Joaquin Valley is to get more data. All of the possible data from USGS was gathered for each year shown.

References

USGS. “Measuring Land Subsidence”
https://ca.water.usgs.gov/land_subsidence/california-subsidence-measuring.html