

# **Brazoria County, Texas**

## **Analysis of Sulfate and Chloride Concentrations**

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## **I. Goal**

Analysis of sulfate and Chloride concentrations

The main purpose of this project is the analysis of water quality in the Brazoria County, Texas. Such analysis will be done by comparing concentrations of Sulfate and Chloride present in the water over a certain period of time. I will be using water sample measurements from the Gulf Coast aquifer which is the main aquifer system underlying the county.

## **II. Statement of the Problem**

### **Background**

Freshwater resources provide essential services to society. Without doubt, the most important of these services is safe fresh drinking water for all populations around the world. Nevertheless, not all water bodies provide humans with what is considered suitable water for our consume.

Commonly water quality is assessed through the use of many different parameters and methods ranging from simple test kits measuring properties like pH for instance, to much more complex electronic sensor platforms that can measure a wide variety of characteristics over a long period of time. Through the years, water quality has been greatly degraded by a number of factors including human activities, and now more than ever it is crucial that analysis of the quality of water resources are made time to time.

### **II.1 Assessing the Problem**

So, an assessment of the concentrations of Sulfate (SO<sub>4</sub>) and Chloride (Cl), will be made to help determine the quality of water of the aquifer as well as estimate the degree by which these concentrations are due to saltwater intrusions (movement of saline waters into fresh water aquifers); a phenomenon that is very common in most coastal aquifers due to the hydraulic connection between groundwater and seawater. The comparison will be made between two time periods 1960-1967 and 2000-2010, and the water samples are all from the Gulf Coast aquifer system, which is the main source of water for the county.

## **III. Data Sources**

Data used for the project was collected from essentially two sources:

**1) Texas Water Development Board:**

<http://www.twdb.state.tx.us/groundwater/data/gwdbbrpt.asp> Groundwater data at TWDB and well locations.

a) Report 163 Ground-Water Resources of Brazoria County, Texas by William M.Sandeen and John B. Wesselman.

--- Provided all the information about water quality and well location for the County of Brazoria.

**2) Texas county polygons - Texas Natural Resource Information Service (TNRIS),**

Stratmap project: [http://www.tnris.org/get-data?quicktabs\\_maps\\_data=1](http://www.tnris.org/get-data?quicktabs_maps_data=1)

--- Provided a county boundary shapefile for the entire state of Texas.

#### **IV. Constructing the GIS Database**

Procedure:

- A- Limiting Brazoria as the county of interest.
- B- Conversion and manipulation of well data for the County.
- C- Importing well data into ArcGIS and creating a shapefile.
- D- Binding Geo-statistical data within the county boundary.
- E- Interpolating well shapefile data to create raster data models.
- F- Performing raster calculations to analyze changes in constituent's concentrations over time.

#### **A Limiting Brazoria as County of Interest:**

After downloading a county boundary shapefile for the entire state of Texas, and verifying that it was in the same coordinate system as the well location data (in this case GCS\_North American Datum\_1983), the first thing to do was select Brazoria county from the other counties, and

export it in order to create its individual shapefile.

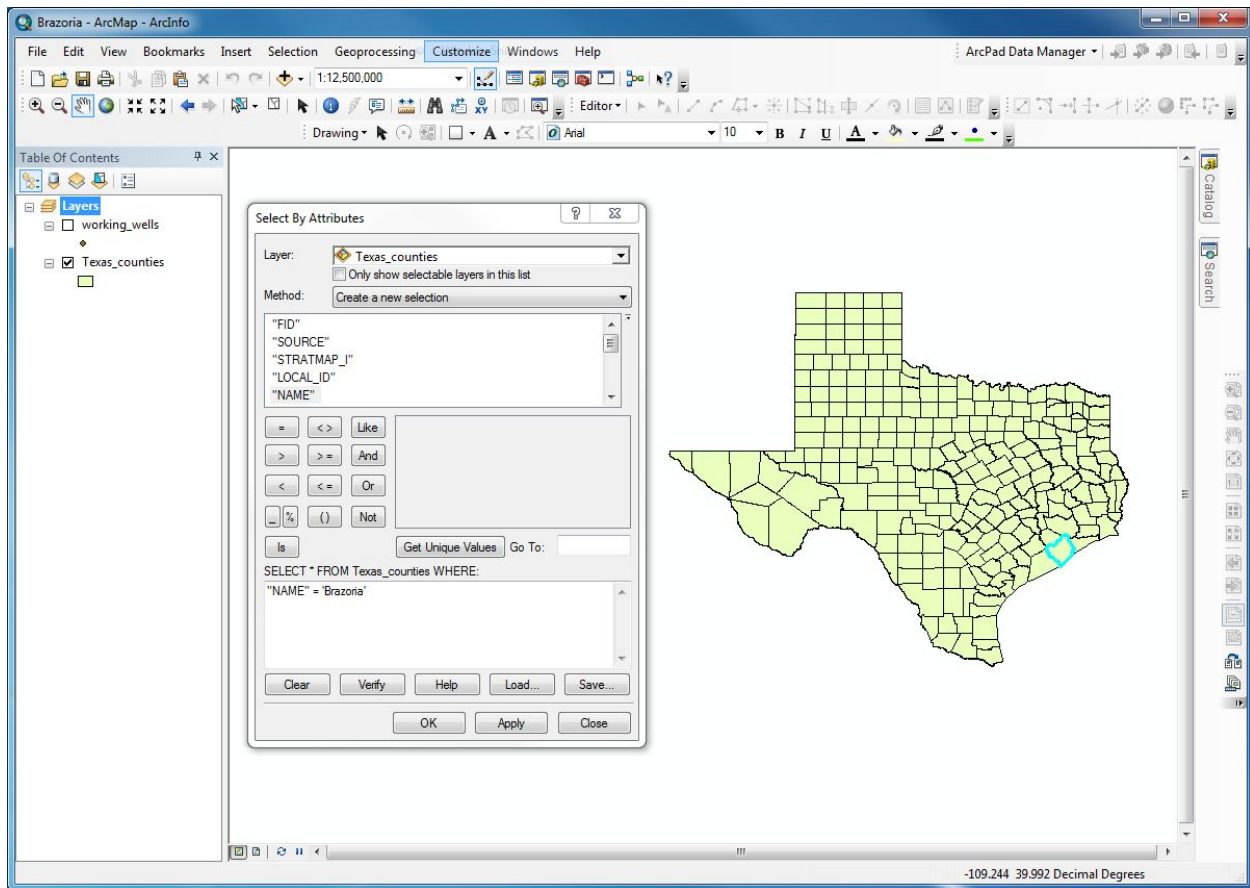


Fig: 1a

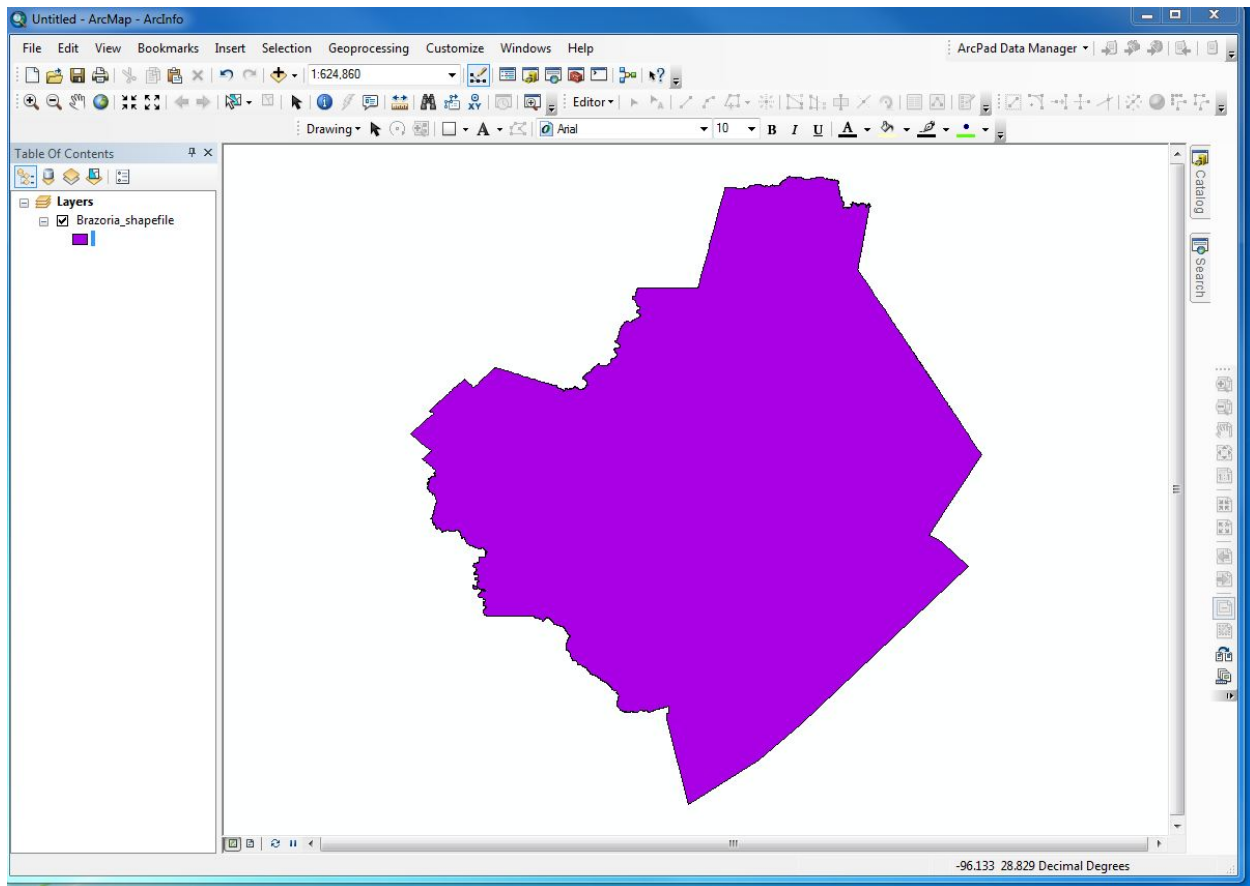


Fig: 2a

## **B: Conversion and manipulation of Well data for the County**

Well location and water quality data, which were provided by the Texas Development Board, was initially downloaded as text files as illustrated in figure 1b. The text file, contained a humongous amount of information that was both difficult to understand/read and very hard to manipulate.

In order to work with these data, I had to first convert the text file into an excel document, which presented the data more clearly and also allowed me to omit all the statistics irrelevant for the project without much struggle. The data contained in the final version of the excel file is as follow: State well no, sample year periods 1960-1967, sulfate and chloride concentrations, and sample year date 2000-2010, sulfate and chloride concentrations (fig 2b).

Additionally, I divided the well data into two different time periods, a task that required running a query. By making a selection by attribute for all wells  $\geq 1960$ , and wells  $\leq 1970$ , and then repeating the same process for the period 2000-2010 doing a selection for all wells  $\geq 2000$  and wells  $\leq 2010$ .

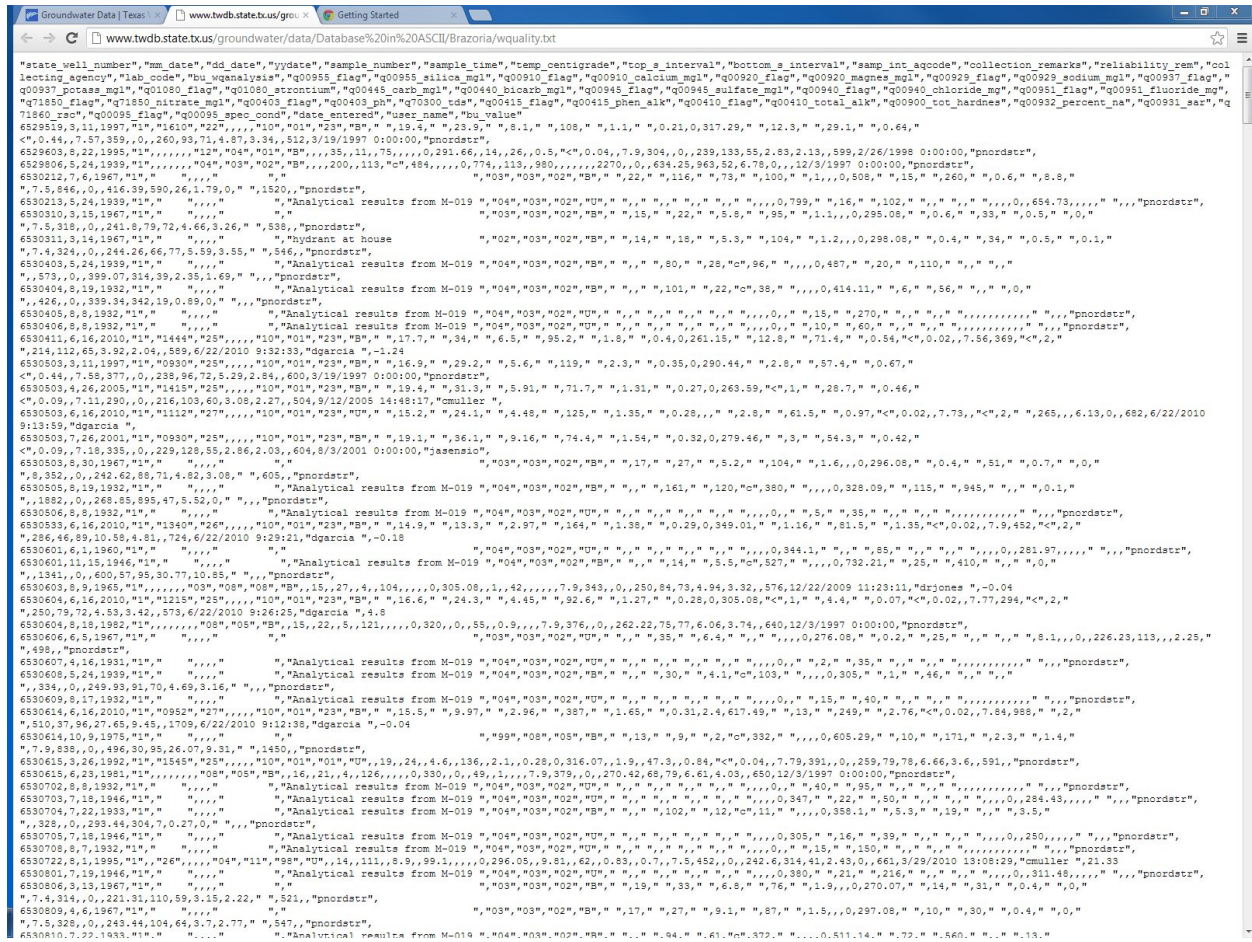


Fig 1b

FID	state_well	well_no	yydate	sulfate	chloride	well_no_1	yydate_1	sulfate_1	chloride_1
2	6543901	6543901	1960	28	93	6559803	2000	2	113
3	6561105	6561105	1960	2	970	6530503	2001	1	42.7
4	6545101	6545101	1962	25	113	6543901	2001	27.3	108
5	6561508	6561508	1964	5	131	6546101	2001	24.5	339
6	6530603	6530603	1965	1	42	6550102	2001	8.68	86.4
7	6538404	6538404	1965	15	62	6550806	2001	1	460
8	6561703	6561703	1965	113.7	274	6551102	2001	1	488
9	6561706	6561706	1965	0.3	225	6551401	2001	1	717
10	6561911	6561911	1965	13	115	6559102	2001	23.5	130
11	6537703	6537703	1966	0	56	6559431	2001	1	409
12	6530212	6530212	1967	15	260	6561205	2001	14.8	143
13	6530503	6530503	1967	0.4	51	6561706	2001	3.34	170
14	6543705	6543705	1967	28	292	6561911	2001	13	280
15	6543804	6543804	1967	5.2	50	6562802	2001	1	334
16	6544306	6544306	1967	20	49	8105315	2001	0	225
17	6544308	6544308	1967	1	60	6530603	2005	1	235
18	6544602	6544602	1967	15	16	6543705	2005	1	114
19	6546101	6546101	1967	20	76	6543804	2005	29.4	80.8
20	6550101	6550101	1967	11	700	6544306	2005	27.1	165
21	6550102	6550102	1967	12	725	6545101	2005	1	116
22	6550605	6550605	1967	20	520	6550101	2005	6.78	85.1
23	6550805	6550805	1967	24	171	6550805	2005	1	575
24	6550806	6550806	1967	26	117	6551302	2005	1	700
25	6551102	6551102	1967	15	213	6553404	2005	8.02	221
26	6551302	6551302	1967	0.6	130	6559101	2005	22.4	136
27	6551401	6551401	1967	21	265	6559428	2005	1	356
28	6552903	6552903	1967	149	154	6561105	2005	13.8	144
29	6553404	6553404	1967	141	198	6561703	2005	31.9	123
30	6558301	6558301	1967	14	85	6562104	2005	6.5	437
31	6558303	6558303	1967	64	116	6562604	2005	1	511

Fig 2b

### C. Importing well data into ArcGIS creating a shapefile:

Excel data was imported into ArcMap using the Add X, Y technique; however this data initially had two problems. For one the excel file in ArcMap was an “event” rather than a shapefile, and secondly, its attribute table showed that some data was left out. So I had to do some manipulations to the excel file once again so that it could be good for use in the project.

I went back to the original wells-location for the county, opened its attribute table, selected the joins and relates tool and by choosing the option Keep only matching records I was able to recover the missing information. Finally, the attribute table shows that data was carried successfully. The next step was to create a shapefile for the Excel data. I created one different shapefile for each time period (wells\_1967shp, and wells\_2010shp).

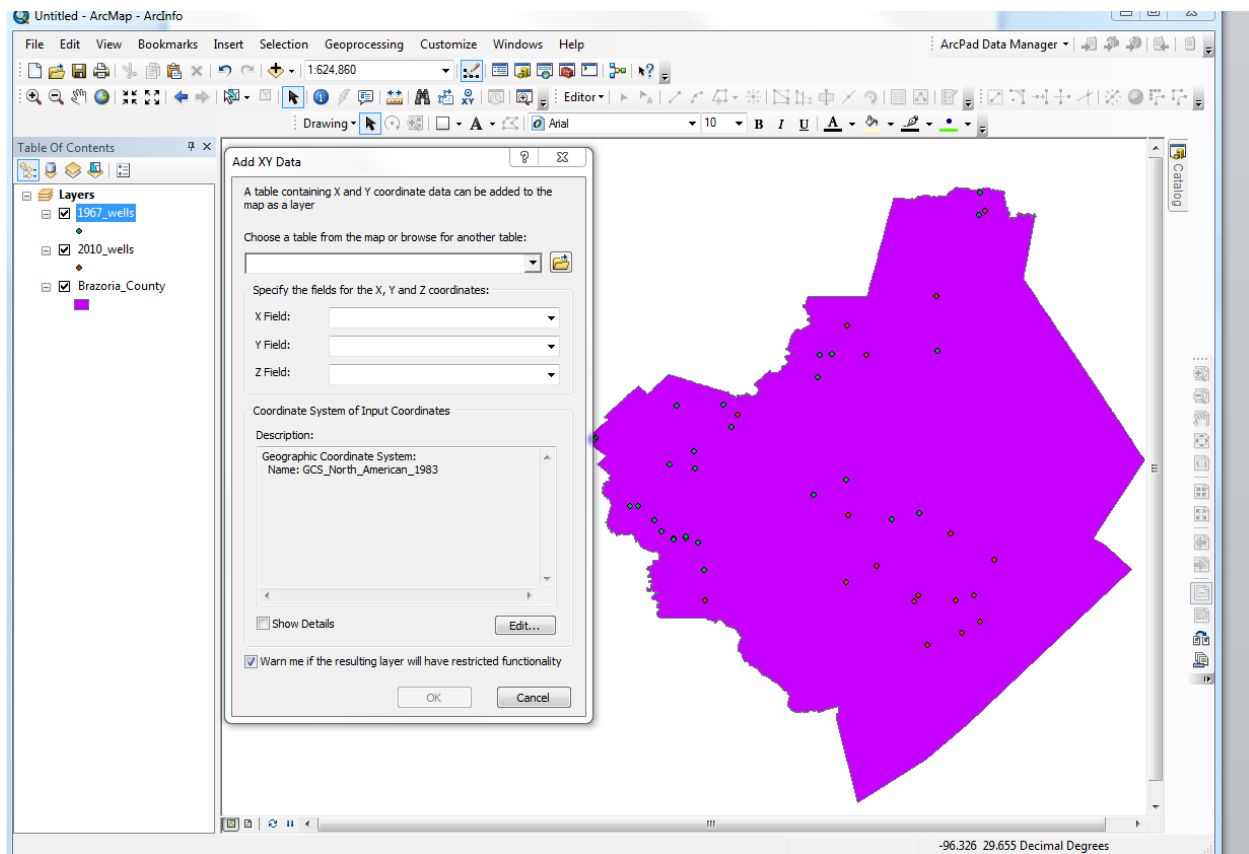


Fig 1c

#### D. Biding geo-statistical data within the county boundary:

A very simple but crucial step to assure that all raster models will be contained within the county boundary. This can be done by setting Brazoria County as the boundary to be clipped within the data frame properties (Fig. 1d)



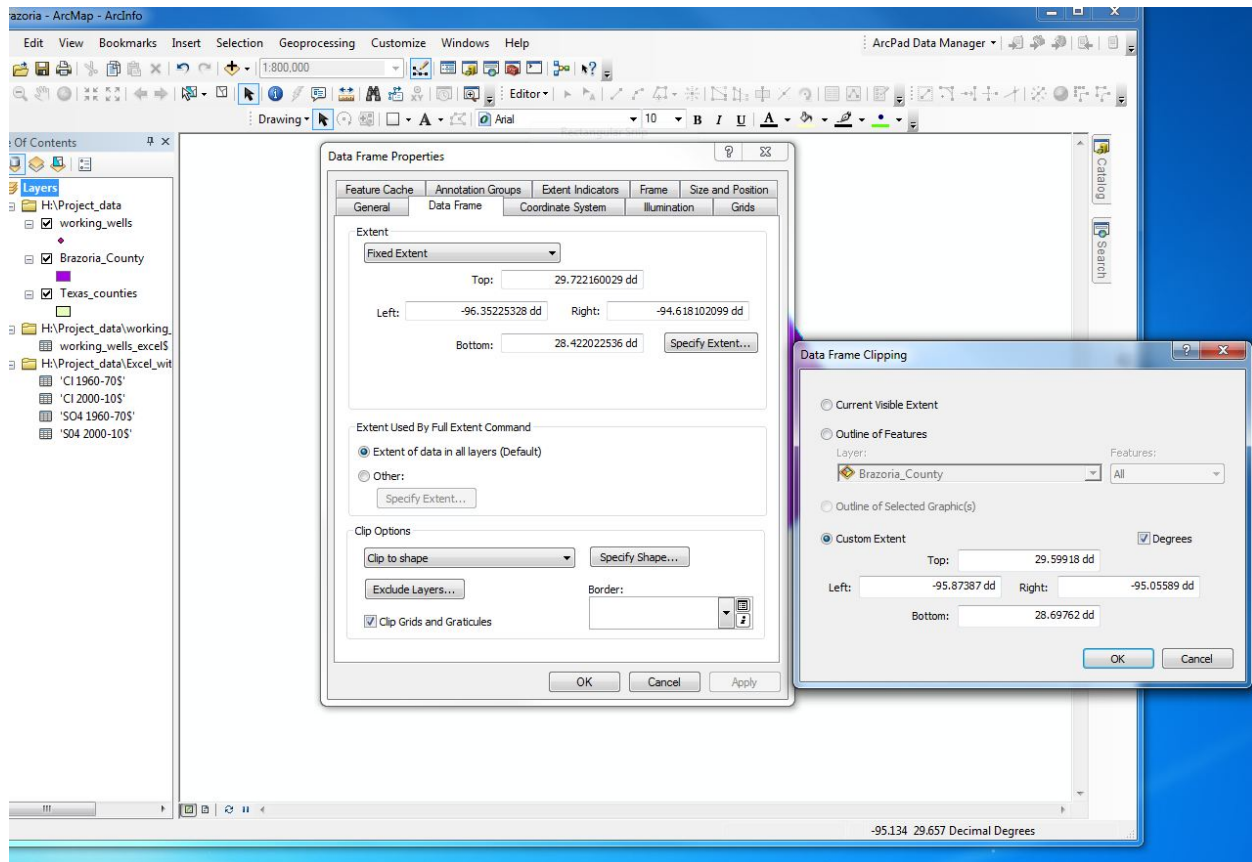


Fig.1e

### E. Interpolating well shapefile data to create raster data models:

After bidding the geo-statistical data within the county boundary, the next step was to convert the recently created shapefile into a raster model that would help see the concentrations and also enable us to perform calculations that would clearly show the changes in the concentrations of both constituents. After several ineffective attempts with the Kriging tool, creating the raster data was attained by using the IDW interpolation tool under the spatial analyst tool within Arc Toolbox. The inverse distance weight method turned out to be a better option since it weights the points closer to the prediction locations to a greater degree than those that are farther apart. Something that will help distinguish the areas were errors are likely to have affected the results from the areas were errors were almost ignored. At this step, a semivariogram model for data interpolation was also selected. The Gaussian method works better for the purposes of the project, and I also set the environments for the cell size to maximum inputs and created a mask

to Brazoria County. Fig 1e shows the result, which is a raster model that shows different concentrations of constituents at different times.

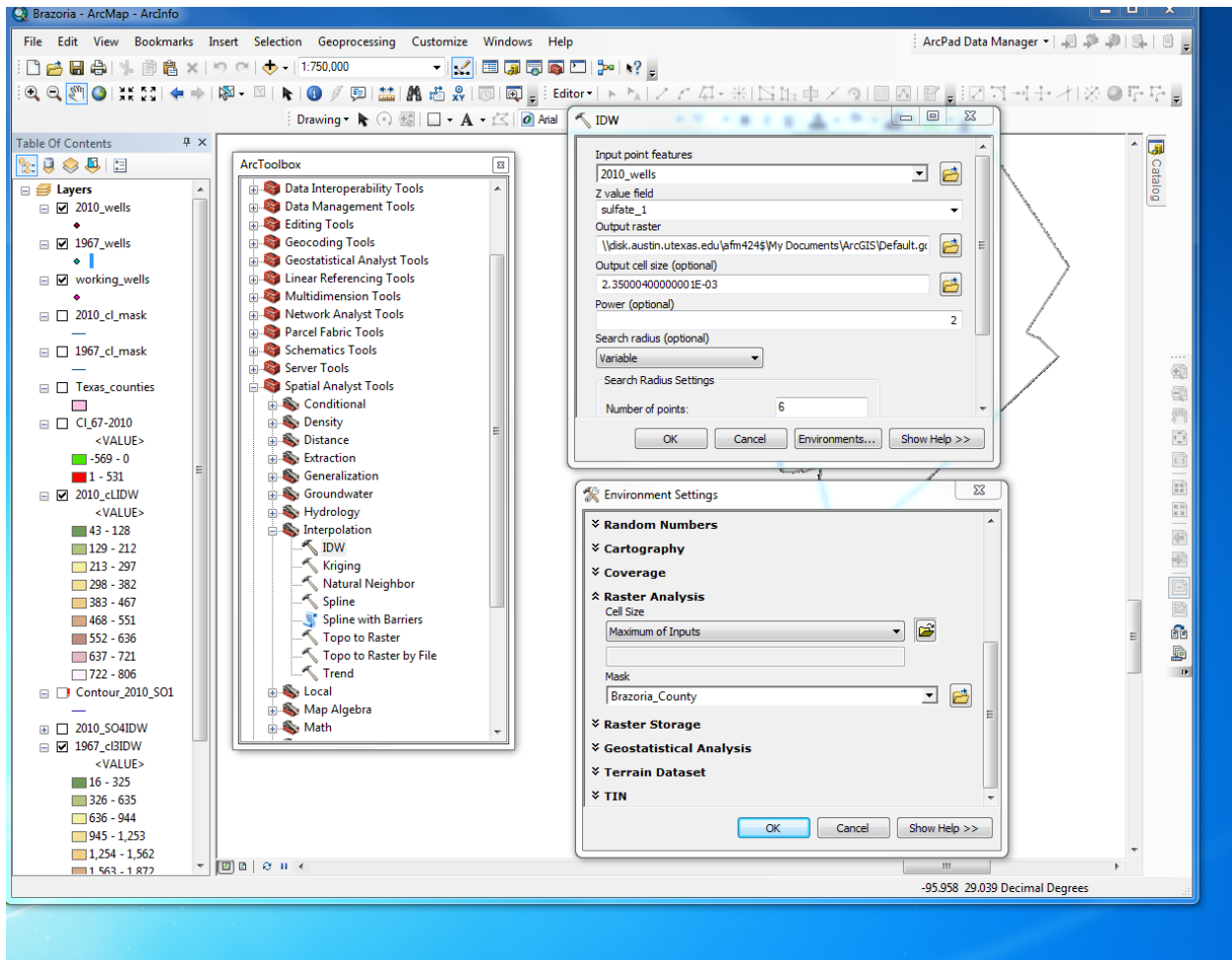
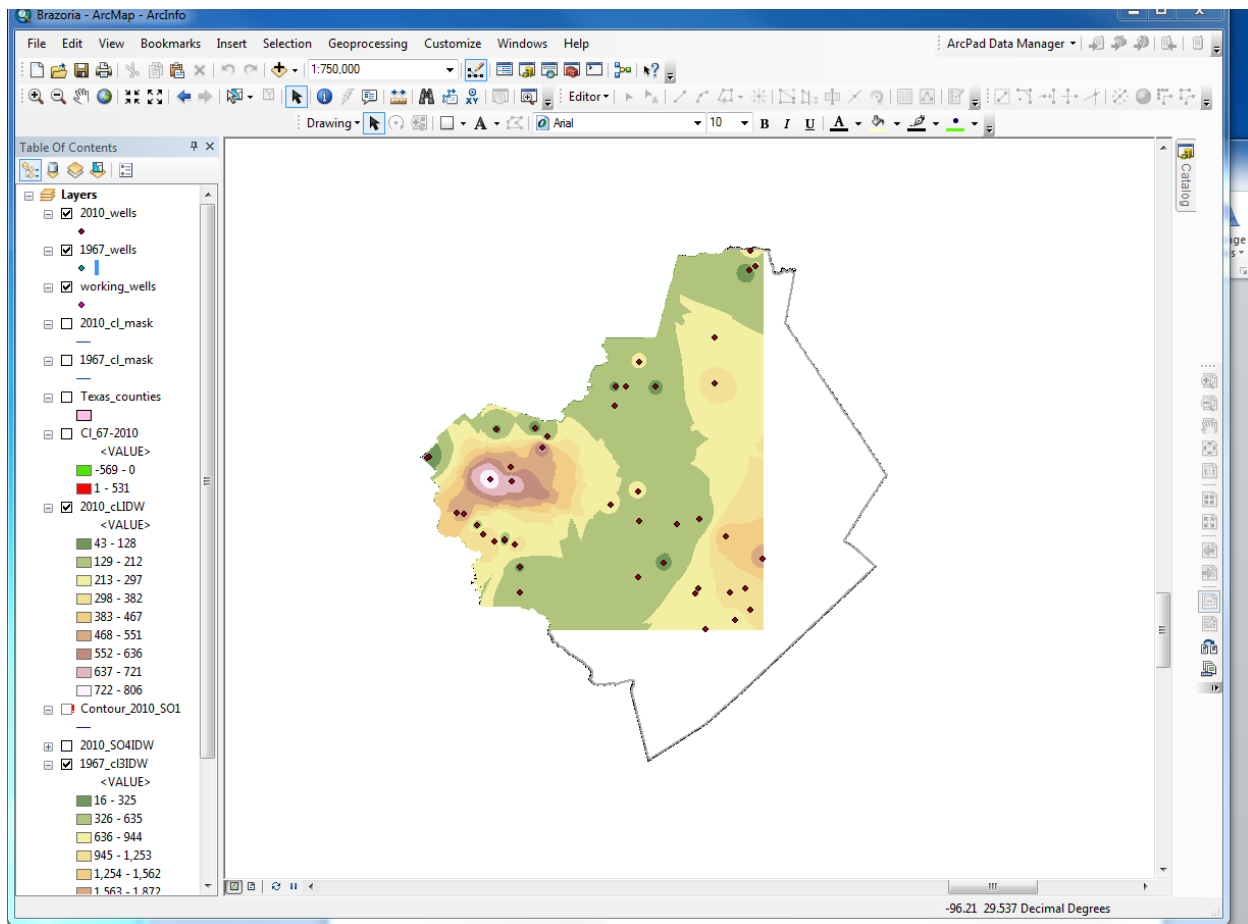
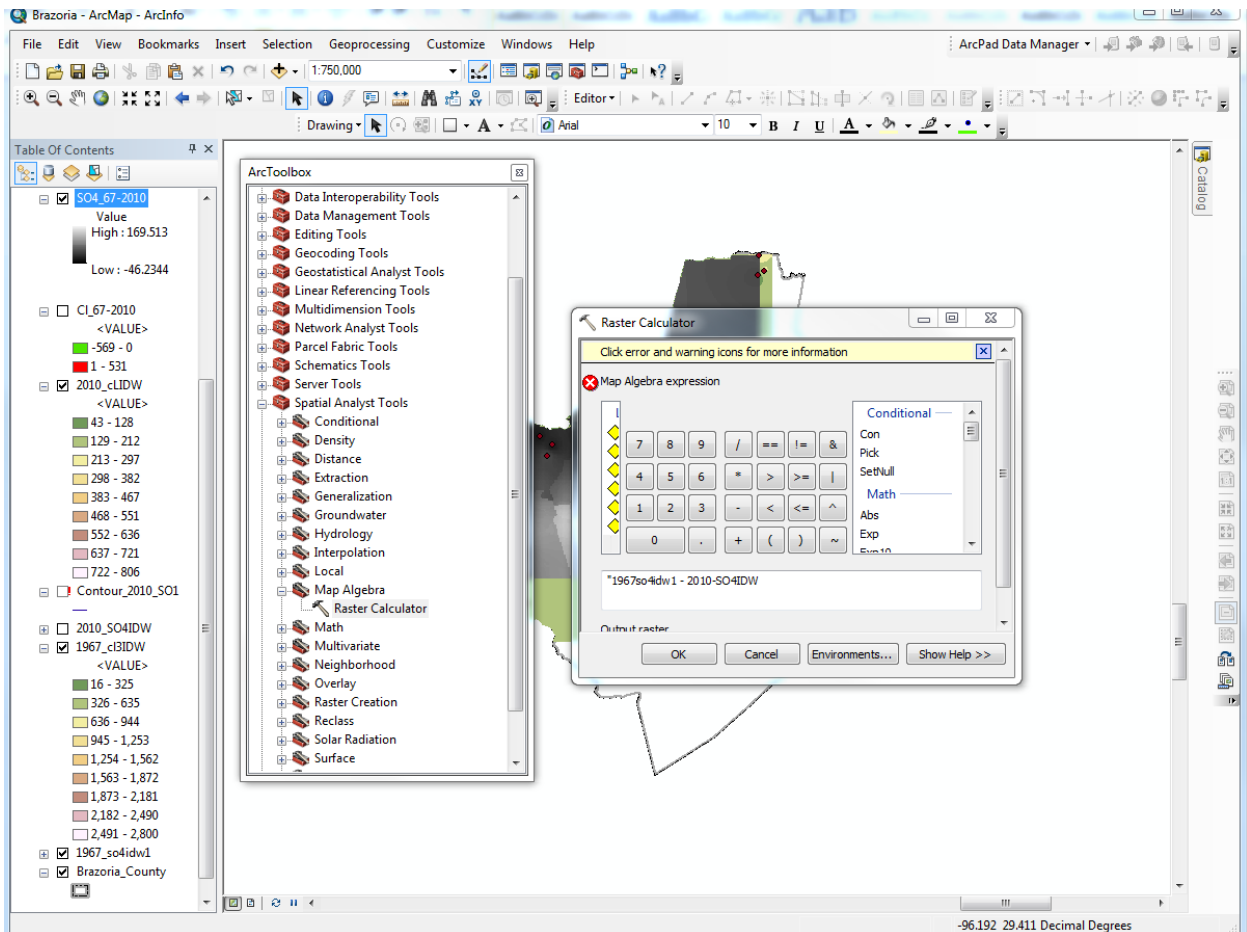


Fig 1e



### G. Performing raster Calculations to analyze changes in sulfate and chloride concentrations over time:

Changes in the concentrations of both sulfate and chloride were made using the raster model above created. Under the spatial analyst tool, I select the Raster Calculator in order to perform my calculations accurately. I first subtracted the Chloride concentrations of the year 2010 from the year 1967 (Cl 1967-Cl2010) fig 1g, and then the Sulfate concentrations of the year 1967 from the 2010 (SO4 1967-SO4 2010) fig 2g.



### Changes in Sulfate concentration:

Min. = -46.234mg/l

Max= 169.51 mg/l

Mean= 26.869mg/l

Std dev= 33.147mg/l

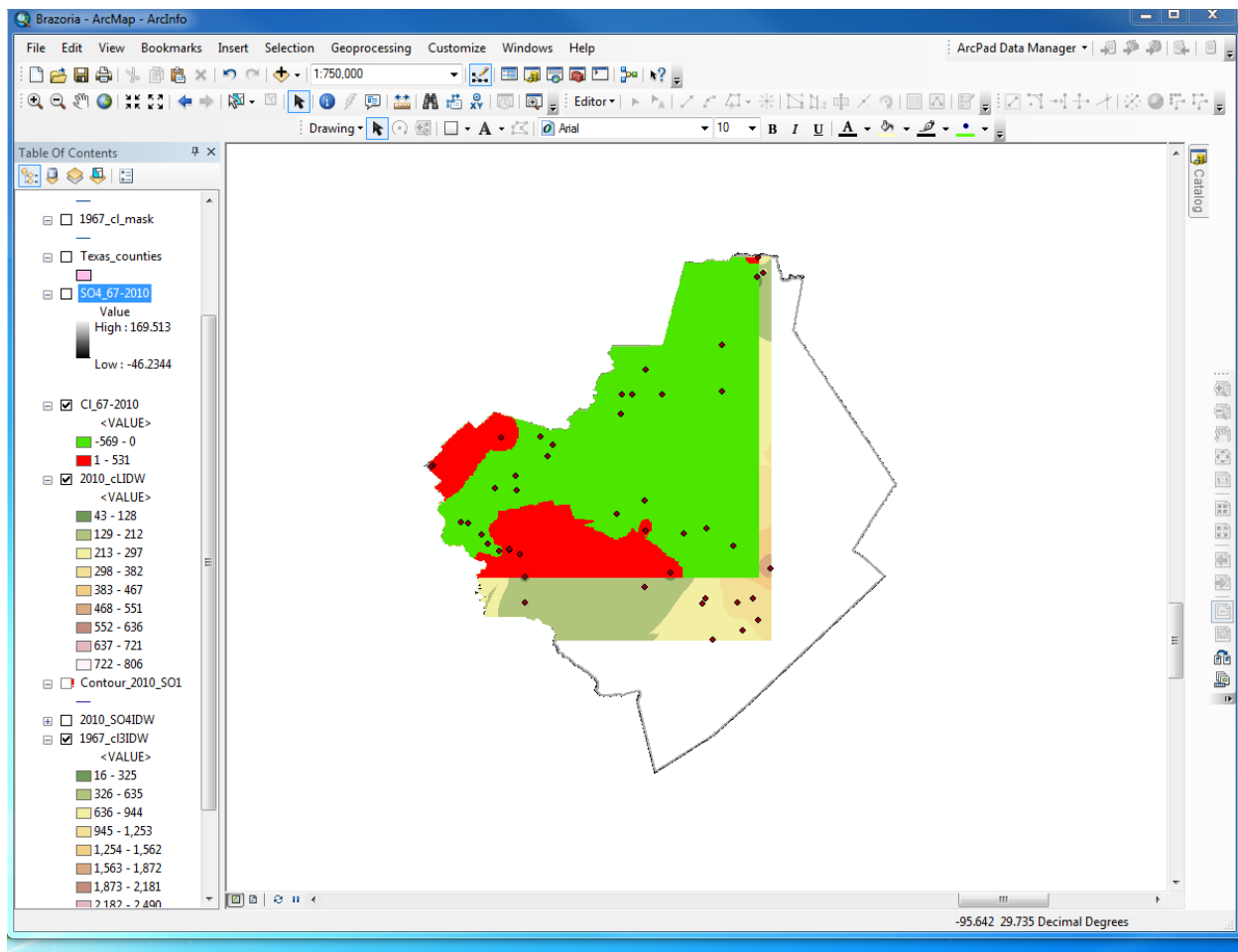
### Changes in Chloride concentrations:

Min= -568.83mg/l

Max= 2656.4mg/l

Mean= -38.165mg/l

Std dev= 247.37mg/l



**Fig. 1g**

**Conclusion:**

It is hard to accurately explain the true reasons behind the changes in the concentrations of both sulfate and chloride in the county of Brazoria. By the raster data analysis, one can easily see that there is an increase on the chloride concentrations towards the middle of the county (green color), just like the loss also occurs away from the coast (red color) from 1967 to 2010.

Surprisingly enough, the same happens for the sulfate concentrations which shows a slight decrease near the middle area of the county (dark pink color) and an increase also away from the coast line (blue color).

So, considering just this, one could very easily conclude that saltwater intrusions cannot be the cause of high concentrations of sulfate and chloride in the freshwaters of the Brazoria County;

otherwise the increase would not be seen towards the areas that are farther away from the coastline of the Gulf of Mexico.

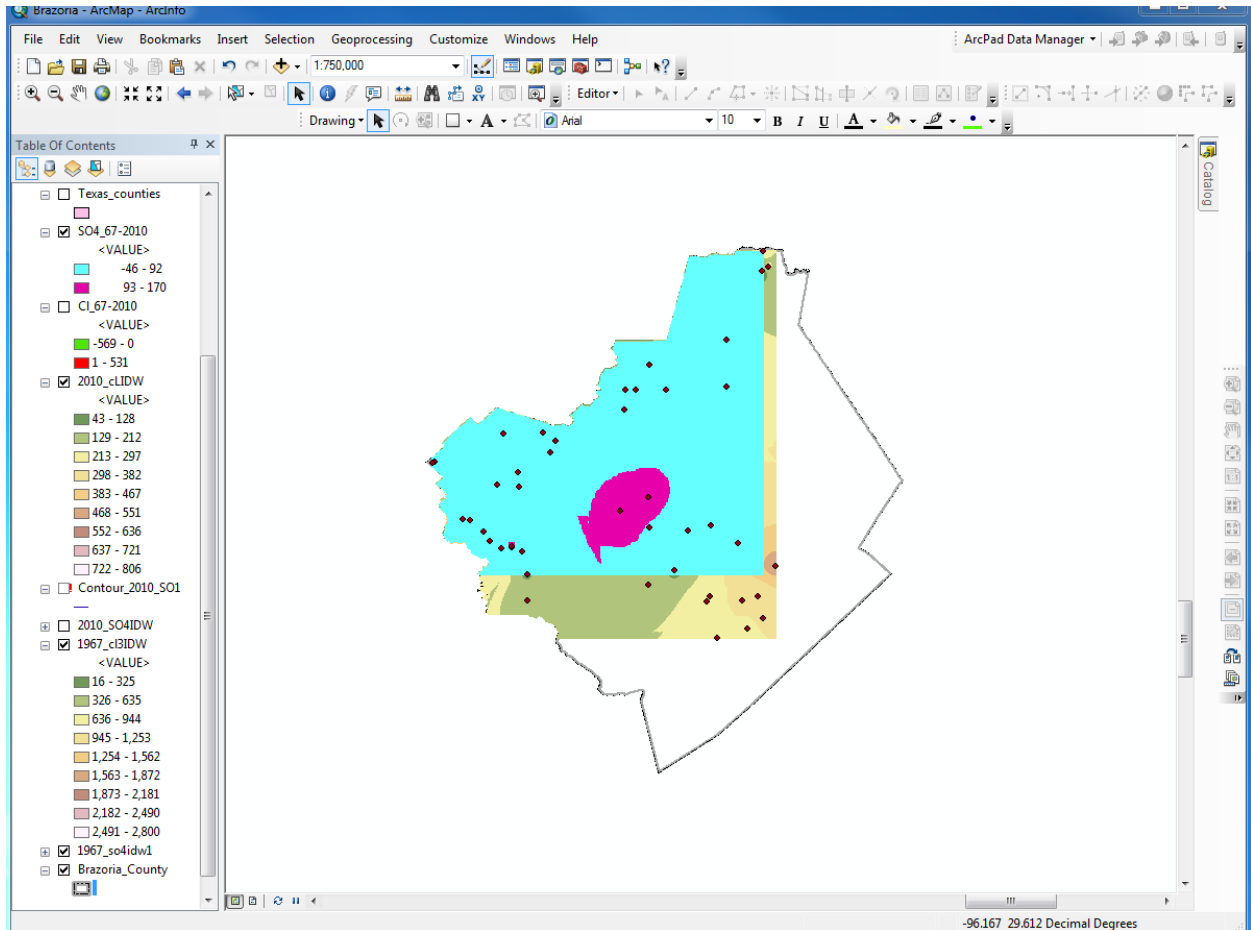


fig.2g

However, the issue is a really more complicated than that and a conclusion cannot only be derived from the raster results. It is equally important to consider the area in which the wells are located, which in this case we do not have well data along the coast. So one might use this as an explanation, yet this option can be quickly eliminated using a similar argument; there is still well data relatively much closer to the coast and the area doesn't show any kind of increase at all.

A third conclusion would be that the saline waters have intruded farther into the county and thus we have now increase of both chloride and sulfate in the central, northern, and eastern portions of Brazoria. Nevertheless, the numbers imply something different:

---The difference in the minimum and maximum concentrations is considerably great for the sulfate and drastic for the chloride.

--- The standard deviation values are much larger than the mean values in both changes of chloride and sulfate over time (which could mean that the concentrations have stayed the same over time).

Furthermore, with the IDW interpolation technique the concentrations of chloride and sulfate between the data points close together are were weighted more heavily upon higher density data than the ones farther apart.

### **Overall Picture**

The accuracy of this project and the GIS data created would be further enhanced by the following:

\*A greater amount of wells in general (to maintain standard distance), and more specifically near the coastline.

\* Interpolation of other constituents to analyze other correlations.

\*Correlation of data with other counties along the Gulf of Mexico.