Getting Maps and Plotting Data on a Map

July 30, 2007

Sections with asterisks (*) are optional and only covered if time allows.

In this tutorial we will learn several things. By the end of this tutorial you should be able to

- Find and download a map from the ESRI site.
- Identify which layers are appropriate for use in your analysis.
- Look at a ArcGIS shapefile without having to import it into GRASS.
- Import a shapefile into GRASS.
- Perform maintenance on an image so that GRASS can use it correctly.
- Save your work for future use.
- Plot data points onto the downloaded map.
- Vary attributes of the points based on the data.

Using Maps from ESRI*

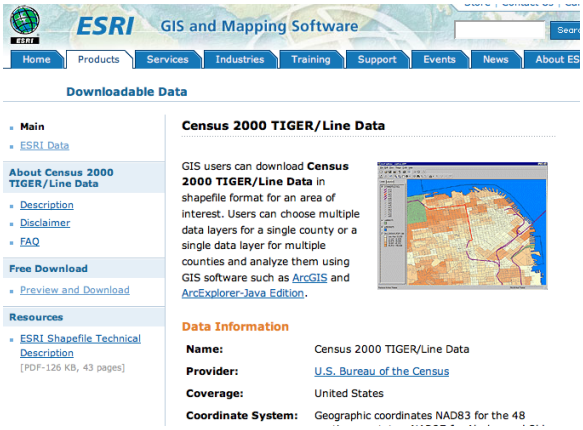
The company that markets ArcGIS has a very large site containing maps and shapefiles that can be included in your GRASS maps. For this tutorial we will use *Census 2000 TIGER/Line Data* which can be found at

`http://www.esri.com/data/download/census2000_tigerline/index.html`

There are many other datasets on this site that you should explore at some point. The free datasets can be found at the Geography Portal at

`http://www.esri.com/data/resources/geographic-data.html`

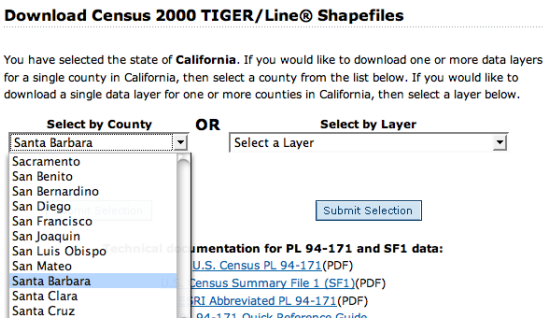
To get started, **click on the Preview and Download link in left hand side of the page**.



In the next step, you will select a state for which you want data. Select **California** and hit next.

Then select the California county that you want data for. Select **Santa Barbara** and click the `Submit Selection` button below the `Select by County` drop down menu. Note that if you want

data for all of California and not just a particular county, you can select a data layer from the `Select by Layer` menu.

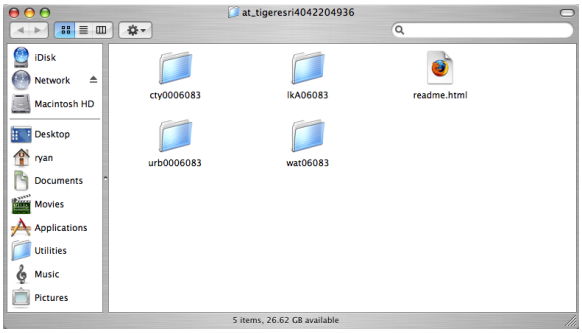


You are now taken to a long list of available data layers available as shapefiles. For this tutorial check off the following boxes:

- **County 2000** contains the boundaries of the county we have selected. *It is important to note that the boundaries denote all area owned by the county* ***including*** *coastline and ocean out to a certain depth or distance.*
- **Line Features - Roads** contains all roads and highways in the queried county. We also have access to the attribute table that lists the road names.
- **Urban Areas 2000** contains the locations of the areas in the queried county designated as urban areas according to the 2000 US Census. An attribute table includes the names of these areas. As an exercise, we will plot the names of these cities.
- **Water Polygons** contain the area in the queried county that are designated as bodies of water. These include not only rivers, streams and lakes, but also the section of the ocean that belongs to the county.

Once you have selected these layers, click on `Proceed to Download` then click on `Download File` on the resulting screen. This will download a ZIP file to your default downloads location. On Mac, locate the file and double-click it to extract its contents to the same directory. On Windows XP and Vista you can double click the zip file but you will need to extract the contents manually. On previous versions of Windows you will need a zip client such as WinZip or WinRAR to extract the contents of the file.

NOTE: The filename of the zip archive and the extracted directory may differ from what is pictured in this document. That is no problem.



Notice that the names of the directories are rather cryptic. There is a system for how ESRI names its TIGER files, and it can be found in the `readme.html` file. For brevity, the table below maps the directory name with the list of layers on the previous page.

Directory Name Format	Description of Contents
`cty00xxxxx`	County 2000
`lkAxxxxx`	Line Features - Roads
`urb00ccccc`	Urban Areas 2000
`watxxxxx`	Water Polygons

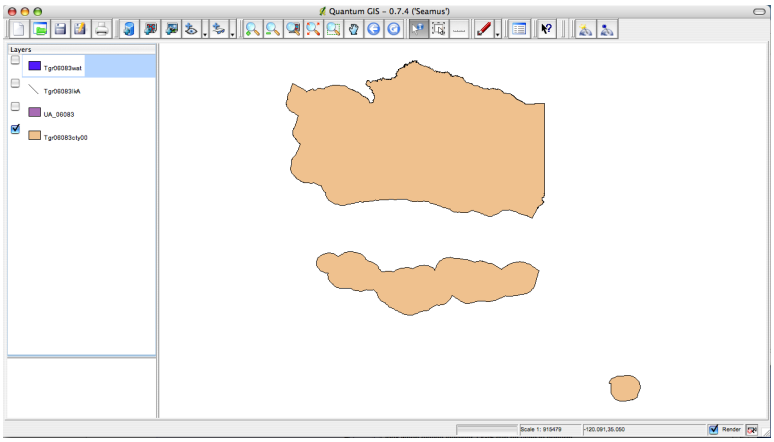
`xxxxx` represents the unique code used to identify the particular county we queried. This code for Santa Barbara County is 06083.

Within each of these directories, one will find several files. We will only deal with the files with `.shp` extension.

Looking at the Shapefiles*

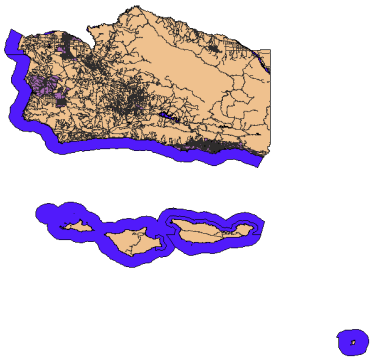
Using an application called QGIS, we can look at what each shapefile contains and how several layers look when plotted together. QGIS is a great tool for exploring data within shapefiles *without* having to import them into GRASS first. You can download QGIS at `http://www.qgis.org`. **QGIS is not necessary to follow along in this section.** We can also use QGIS to rearrange and modify layers, but I will not discuss that.

The following graphic intoduces the QGIS graphical user interface, and also illustrates the `cty0006083` layer. One that is familiar with Santa Barbara County notices immediately that something is not right!



Remember that the county layer consists of all area within that county's jurisdiction including not only the mainland, but also islands and waters. Part of the Channel Islands are within the county's jurisdiction, in particular, San Miguel Island, Santa Cruz Island, Santa Rosa Island and Santa Barbara Islet.

So why are only three landmasses shown instead of five? The county layer is not making a distinction between land and water owned by the county. If we activate the Water Polygon layer, we see something more familiar. I have also activated all of the other layers to display the power of QGIS as a visualization tool. I also used QGIS to change the color used to shade each layer to something more logical.



We can now see each of the distinct islands as well as the water features in Santa Barbara County including a lake and a river. The urban areas are shaded in lavender and the network of roads are light grey.

Preparing to Import a Shapefile

First we need to create a new location and mapset. Refer to previous tutorials for instructions on how to do this. Below I provide the parameters I use for the location using the command `g.region -p`. Note that it is incredibly easy to get these parameters using QGIS.

Important! The output below displays the fractional part of latitude and longitude using minutes. To convert back to decimals, divide the number after the colon (`:`) by 60. Add a negative sign in front of the `west` and `east` benchmarks since this data is in the western hemisphere.

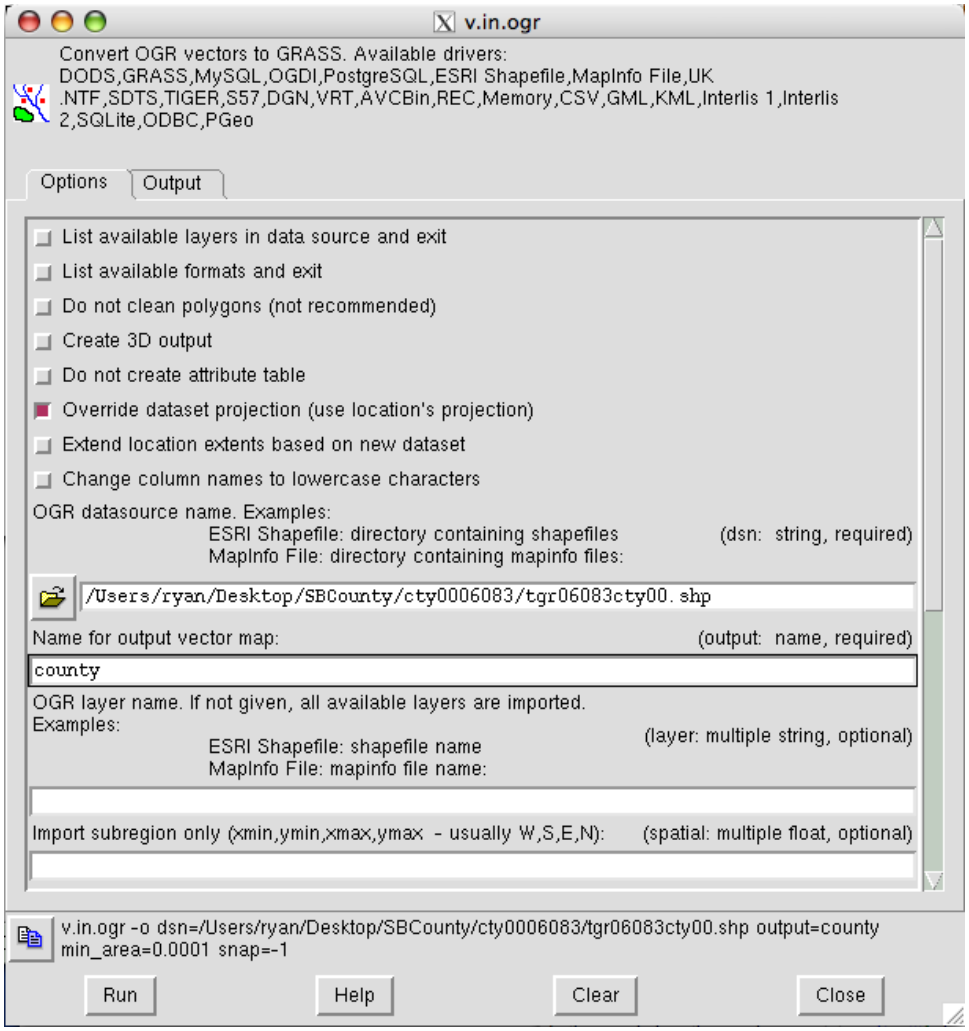
```
projection: 3 (Latitude-Longitude)
zone:       0
datum:      nad83
ellipsoid:  grs80
north:      35:12N (35.2)
south:      33:18N (33.3)
west:       120:48W (-120.8)
east:       119:24W (-119.4)
nsres:      0:00:06.84 (.0019)
ewres:      0:00:05.04 (.0014)
rows:       1000
cols:       1000
cells:      1000000
```

When asked if you wish to enter a specific datum, answer `y` and enter `nad83`. When asked to enter a transformation, enter `1`. These parameters are specific to the files that you are using and may not translate to your particular situation.

For the default region, enter the values in parentheses above, then create a new mapset.

Importing the Shapefiles into GRASS

In the newly created location and mapset, type `v.in.ogr`. The following screen displays.

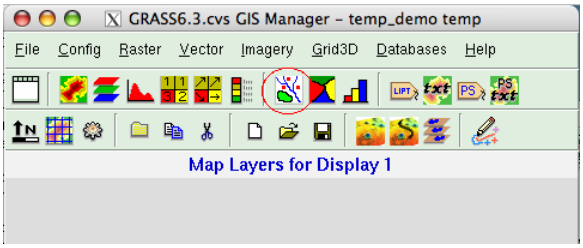


In `OGR datasource name` enter the path to the shapefile you wish to import. You can browse to the file by clicking on the file folder icon. In the `Name for output vector map` enter a name for the vector map.

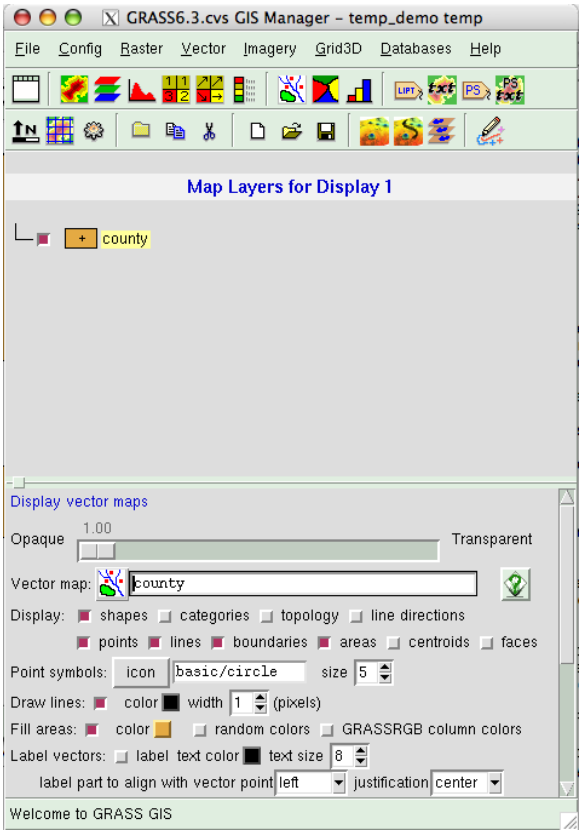
Try running this. If you get an error about projections not matching and you are sure the projections do in fact match, select `Override dataset projection (use location's projection)`. In my particular case, I do get this error, but I know that the projections do match.

Now let's do the same for the **Roads** and **Cities** layers.

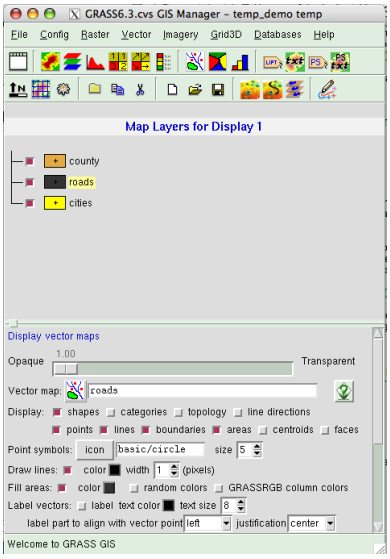
Next, activate the GIS manager and click on the button circled in red to **Add a Vector Layer**. If the GIS manager is not displaying, type `gis.m` in the GRASS shell.



Select options for the layer in the bottom pane, including which vector to import for this layer. For this layer, I just add a background color by clicking the `Fill areas` box and then selecting a clay color in the box to the right of the `Fill areas` box.



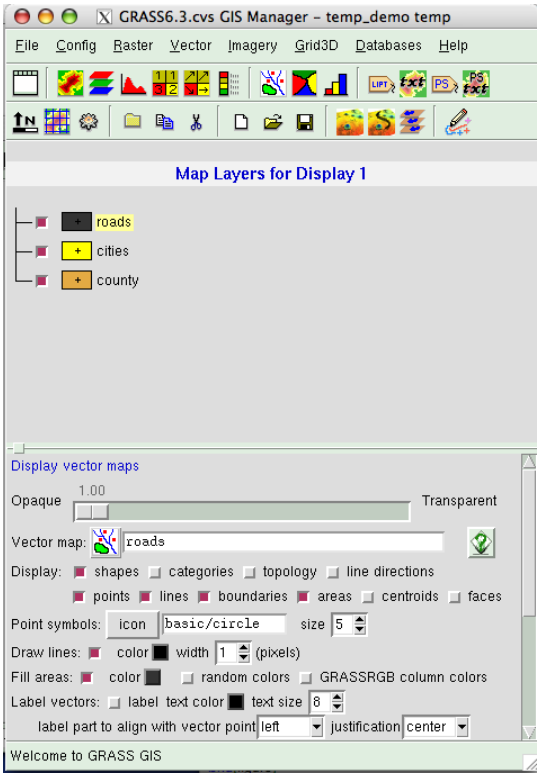
I do the same for the **Cities** and **Roads** layers, except I choose yellow and grey respectively.



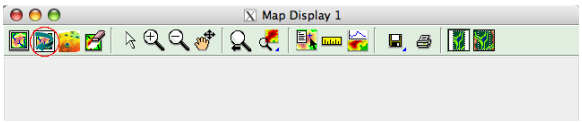
The **Map Layers** section of the GIS Manager displays the order in which the layers will be displayed. Note that **County** is on the top. This means that the County layer will be drawn above all of the other layers, that is, the County layer will hide the other two layers.

We want to plot the County layer first so that it is on the "bottom layer" of the display. Then we want to draw the Cities layer. Finally, we want the roads layer to be the "top layer" so that we see all of the roads.

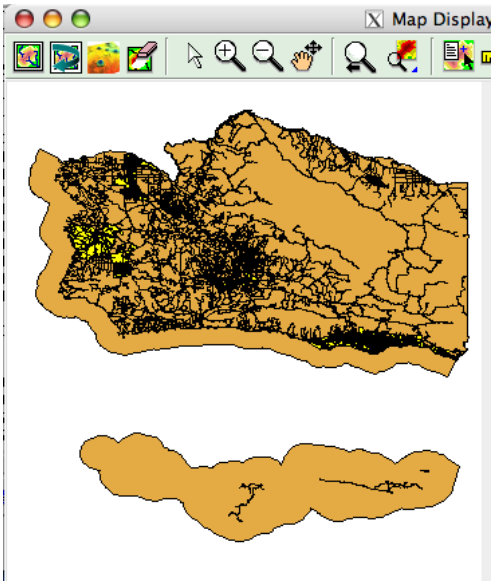
To correct the order of the layers, click on the Cities layer once. Then hold down the (left) mouse button and drag the Cities layer to the position above the County layer. Do the same for the Roads layer. The result should look like



Now click over to the **Map Display** window and click on icon circled in red. You can hide layers in this map by clicking on the red box next to the layer you want to hide in the GIS Manager. Each time you make a change though, you must refresh the map display window by clicking on that icon circled in red.



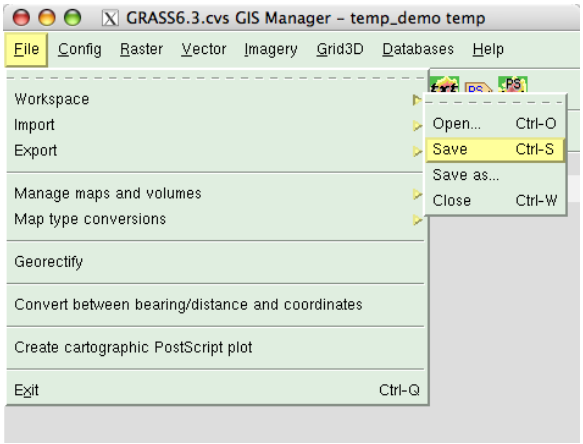
And VOILA! The following map should appear.



Saving your Work

Up to this point we have done a lot of work. In subsequent GRASS sessions we are going to want to start from where we left off. We can save our work in GIS Manager.

To save your work, activate the GIS Manager and click on the `File` menu. Click on `Workspace` and then slide over to `Save`.



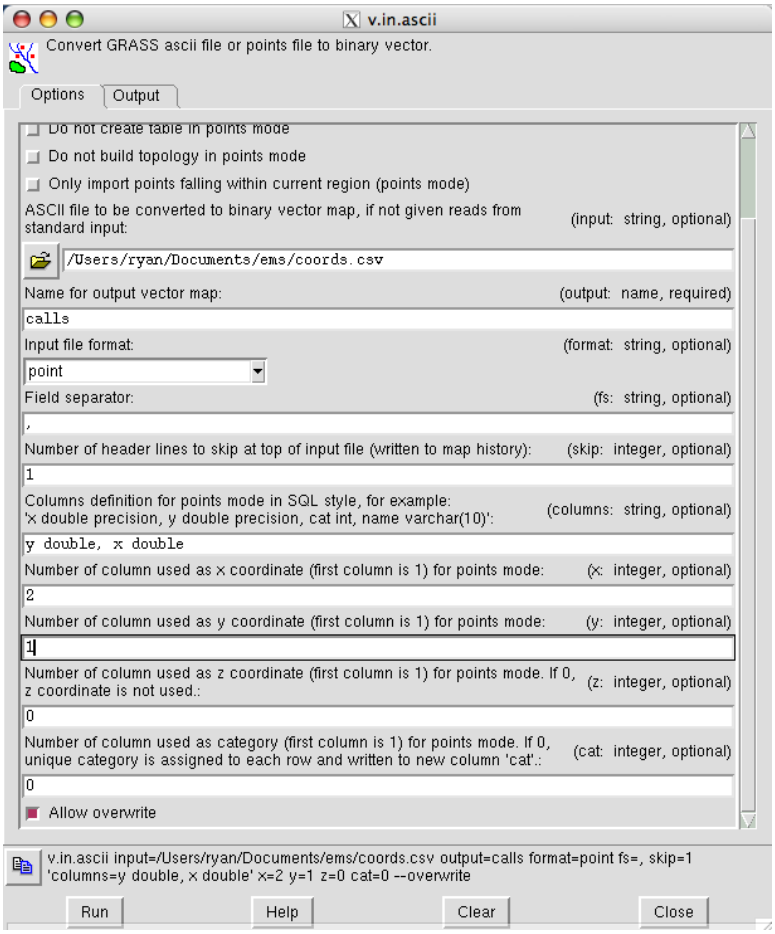
During the next GRASS session, we can reload our work by bringing down the `File` menu. Click on `Workspace` and then slide over and click on `Open`.

Plotting Data on the Map

Now we take some spatial data from R and import it into R so we can plot it on the map. For this example I have a file called `coords.csv` that I exported from R using the `write.csv` function. To give an idea of the file's structure, the first three lines are displayed below. **I only use the latitude and longitude columns in this section.**

```
Latitude,Longitude
34.420757,-119.685126
34.609915,-120.086466
```

While in the same location and mapset that we used for the rest of this tutorial, enter the command `v.in.ascii` at the GRASS shell.



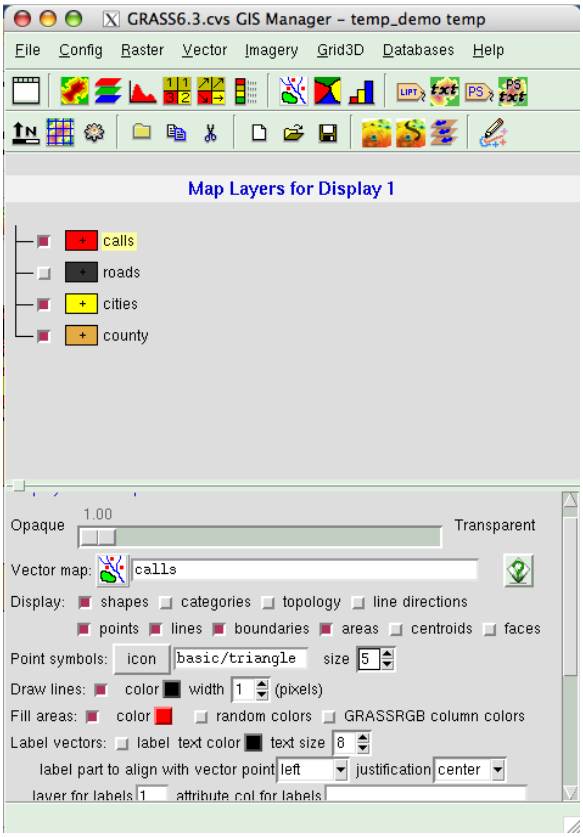
- I enter the path to the file `coords.csv`, or browse to it by clicking on the file folder icon.
- I give a name to the output vector map (`response`) that is created in the `Name for output vector map` field.
- I leave the `Input file format` the same since I am importing a bunch of points.
- I change the `Field separator` from `|` (pipe) to `,`. (who uses the pipe nowadays?)
- Since the first line in my CSV file is a header line, I enter `1` into `Number of header lines to skip at top of input file`.
- The field `Columns definition for points mode in SQL style` requires some explanation. Each of the fields in my CSV can be considered double precision. For consistency, an `x` value

is a longitude value and a `y` value is a latitude value. The first field in my file is latitude (`y`) and the second is longitude (`x`). I tell GRASS this by entering the following: `y double precision, x double precision`.

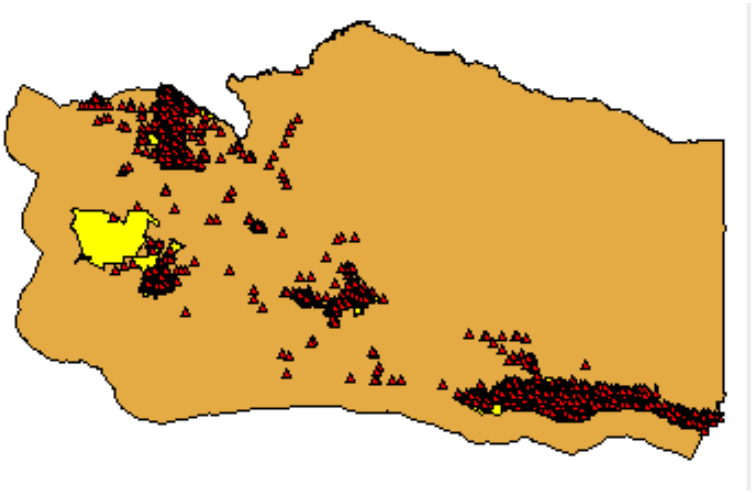
- I enter `2` for `Number of column used as x coordinate` since the second field is longitude which is an `x` value.
- Similarly, I enter `1` for `Number of column used as y coordinate`.
- Since my data is only two-dimensional (there is no elevation component), I enter `0` for `Number of column used as z coordinate` because there is no `z` coordinate.
- I also do not have a category column, so I enter `0` there as well.

Now move back to the GIS Manager and add a new vector layer for the vector `calls`. Move the `calls` layer to the top so it will be displayed above all other layers. It is also wise to **disable the roads layer** so we can see the points more clearly.

Let's customize the points a bit. Select a fill color for the points in `Fill area`. I have selected red. Let's also change the `Point symbols` marker to something else by clicking on the `icon` button. I chose `basic/triangle`. Let's also change the `size` field to `5`.



Move over to the **Map Display** window and refresh the display. Then save your work.



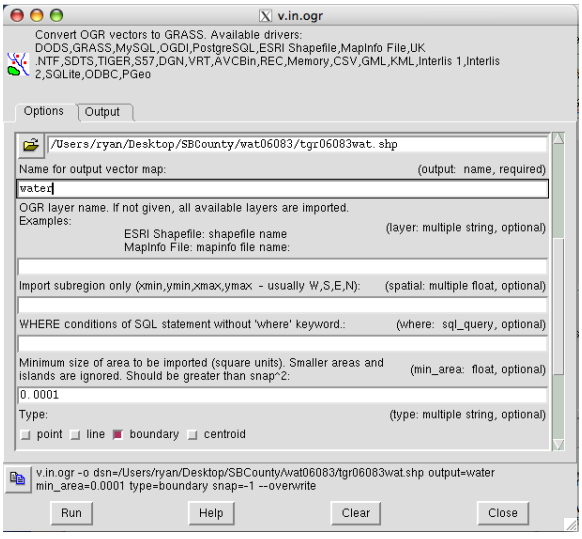
But notice that there is something wrong. Why are there no points along the coast?

Importing the Water Polygon

Remember that the county shapefile contains everything owned or regulated by the county including the land (mainland and islands) and water.

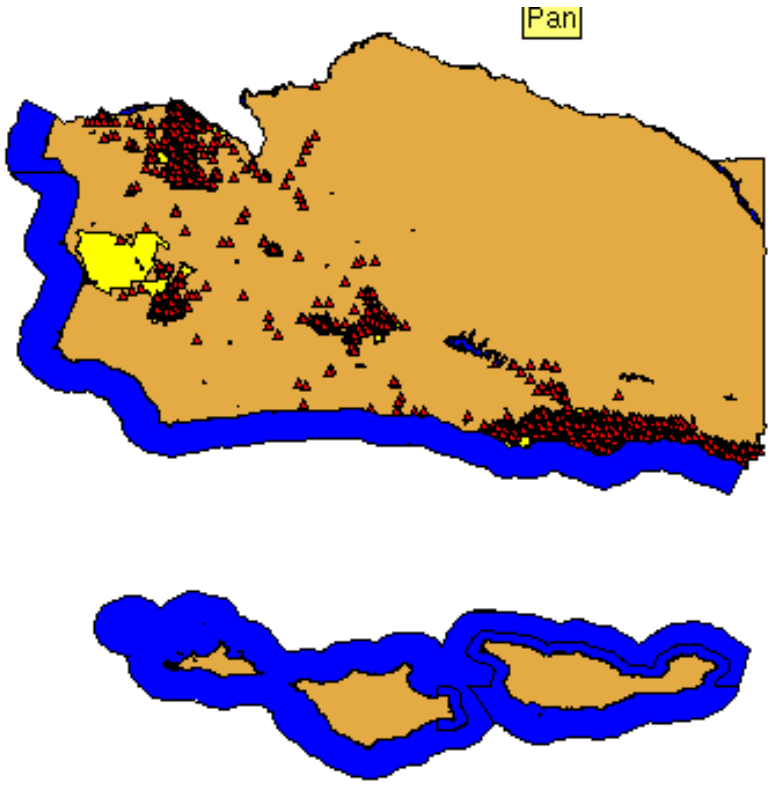
Using what we have learned so far, import the water polygon shapefile, `tgr06083wat.shp`. Using the default settings for the imported shapefile, shading the polygon has no effect. **Try it!**

This is because GRASS does not properly detect the type of shapefile it is. We can fix this by using one of the options in `v.in.ogr`.



In the `Type` section, select `boundary`. We need to do this because for whatever reason, the shapefile consists of boundaries rather than polygons.

By adding a color to this layer (blue is a natural choice), the map looks more appropriate. The final result is on the next page.


Pan