NEW SKILLS:
- GRASS: Reproject data from one mapset to another mapset between two locations.
- Manage your map projection and use projection on the fly.
- Reproject vector data directly in QGIS.
- Reproject raster data directly in QGIS.
- Measure distance and areas.

INTRODUCTION: The objective of this lab is to learn how to deal with projections and projected data for both Vector and Raster formats, in GRASS and in QGIS. In GRASS a location can be thought of as like a folder with all of your data with the same projection, with each mapset being a subfolder to organize separate tasks or themes. As such by definition if you put data into any mapset within a location that isn't of the matching projection it will either fail to import or not overlay with your other data as expected. Why does GRASS enforce projection matching for analysis? Mostly to ensure that analysis functions that require data to overlay will work. While QGIS is very flexible in allowing you to display data from many projections at the same time it does provide you with tools to help you ensure that when you do get to map making or analysis you have reprojected all of your data into a common projection either temporarily or permanently (as a copy). It is highly recommended that you put all of your data into the same projection before doing spatial analysis. The instructions in this lab cover the tools you will need to know to accomplish this.

0. Open QGIS. Before you begin, take the time to move the cursor over the icons along the top and the left side of the window. You will see that many of them are shortcuts to tasks that we did on Lab 1, and others are shortcuts to tasks that we will do. To keep things consistent, the instructions will generally give commands from the menus, but you should also become familiar with the icon shortcuts.

Managing Projections in GRASS
NOTE: As of version 1.7.3 there is a bug in QGIS which has not been fixed as of Version 2.2. I am very grateful to Natalija Aniscenko for suggesting a workaround to this bug.

1. Vector Reprojection with GRASS. In this exercise we will learn how to create a new location and mapset in a different projection. NOTE: If you do not have your work from Lab 1, you will have to recreate it.
   - Use Plugins -> GRASS -> New mapset, following the procedure you carried out in Problem 2 of Lab 1, to create a new location called CalifLamb with a Lambert Azimuthal Equal Area – US National Atlas Equal Area projection. This is a projection, not a geographic coordinate system. In searching for it, it helps to un-expand all of the various projections if they are expanded. Make the GRASS region United States (don’t forget to click the Set button), and the mapset name CalifLambData. Remember that the projection is defined for a location, so that every map within a location has the same projection. This now becomes the active location
   - Now use Plugins -> GRASS -> Open GRASS Tools to locate v.proj (use the Modules List Filter).
   - The next step is to create a new feature layer of the California Counties with a Lambert projection. Assuming you used the same file structure as me in Lab 1 you now type the following:
For the Name of the Input Vector Map type countiesGR,
If you are presented with a selection window rather than a window where you can type a
name, then this is the bug. In this case, skip to problem 1a
For the Path to the GRASS Location type C:\QGISLab\ (make sure you include the last
slash)
For the location type CalifGRASS
For the mapset type CalifGRASSData
For the Name of output map type countiesLamb
• When you get “Successfully finished,” click on the red “Close” button.
• Now open a New Project, and open the mapset you have just created, CalifLambData.
  Add the GRASS vector layer countiesLamb and notice that it is in a different projection.
• Repeat the same process with hospitalsGR to create hospitalsLamb and add this vector
  layer to your project.

1a. The suggestion of Natalija Aniscenko was to use the GRASS shell. This is an excellent
suggestion, because this shell can be used with any GRASS tool. It provides a good alternative in
case you have a problem with the QGIS module window.
• To start, open the v.proj tool again and click on the Manual tab. Scroll the Manual
  window down to Synposis and note that it says

  \texttt{v.proj [-lz] [\textit{input}=name] [\textit{location}=name [\textit{mapset}=name] [\textit{dbase}=path] [\textit{output}=name] [+\textit{overwrite}] [+\textit{verbose}] [+\textit{quiet}]}

  This is a summary of the GRASS command structure.
• We will type the function commands directly into the GRASS shell. Click on the
  Modules Tree tab in the GRASS Tools and click on the topmost icon: shell – GRASS
  shell.
• You will screen with white text on black appear. Assuming you have followed the
  location and mapset naming convention used in the labs, you will type the following
  (don’t type the \texttt{Enter} key in this sequence):

  \texttt{v.proj input= countiesGR location= CalifGRASS mapset= CalifGRASSData output=}

  countiesLamb
• If you have used a different naming convention, modify the above appropriately. GRASS
  is case-sensitive, so be careful of this. Note that you don’t have to specify the dbase
  because it is the currently used one. When you have finished, hit the \texttt{Enter} key. You
  should see a sequence of text indicating that the command is being executed. Close the
  command window.
• Now open a New Project, and open the mapset you have just created, CalifLamb. Add the
  GRASS vector layer countiesLamb and notice that it is in a different projection from that
  of countiesGR.
• Repeat the same process with hospitalsGR to create hospitalsLamb and add this vector
  layer to your project.

2. We will now measure the distance from Modoc Medical Center to Tri City Hospital. First we
will select these two hospitals. This is done in the same way as in Problem 9 of Lab 1.
• Highlight hospitalsLamb in the Table of Contents and click on the Open Attribute Table
  icon. Click on the “Select features using an expression” button.
• Use the buttons in the window to create
  NAME = 'Modoc Medical Center' OR NAME = 'Tri-City Hospital'. The OR operator is
  located under Operators. You may have to click and then double click to get the Fields
  and Values to appear. Why do you use OR and not AND? (Answer is below). Click the
  Select button.
If the selected icons are hard to see, Modoc Medical Center is in Modoc County in the northeast corner of the state and Tri City hospital is in San Diego County in the southwest corner. You can change the color of the selected data by clicking on Project -> Project Properties. The selection color is under the General tab.

Now click on the measuring tool (see Lab 1 Problem 9) to measure the distance between the two hospitals. What is it? (Answer below)

3. Unprojected Data
It is possible to add unprojected data to GRASS. We will create a location and mapset for the Brown’s Pond data set.

- Open a new project and select Plugins -> GRASS -> New mapset.
- In C:\QGISLab create a new location BrownsPondGR. In the Projection window click “Not defined”, and for the limits of the location type 0 for the west and south and 9000 for the east and north. Name the mapset BrownsPondGRData.
- Use Plugins -> GRASS -> Open GRASS tools -> r.in.gdal (see Lab 1 Problem 8 to review how to use the filter ) to add the file elev.asc located in the BrownsPond subfolder of the QGISLab folder. Call the GRASS raster layer elevGR.
- Add the raster layer (click Cancel when asked for a coordinate system). If you have a hard time viewing it, see Lab 1 Problem 6 to switch the display to” Stretch to MinMax.”
- Repeat the process for the file vegeraster.asc to create vegerasterGR in the BrownsPondGRData mapset.
- Now we will add a vector layer. Use Plugins -> GRASS -> Open GRASS Tools -> v.in.ogr to import the file vegevector.shp (make sure you select the file with the shp extension) into a GRASS vector layer named vegevectorGR in the BrownsPondGRData mapset.
- In the same way, import the file buildings.shp into a GRASS vector layer named buildingsGR.
- If necessary, by clicking and dragging the two raster layers in the Layers window, move them to below the vegevectorGR layer so that this is the visible layer. The colors of the vector layer don’t look much like vegetation. Let’s change them.

- Right click on the vector layer and select properties.
- In the upper left corner of the Style tab is a drop down menu that should say “Single symbol.” From the menu the currently says “Single Symbol”, select “Categorized.”.
- In the selection window that says “Column” select Type and then click the “Classify” button in order to have the four vegetation types showing.
- Select each of the vegetation types in turn and click on the fill color. Click on the “Color” in the window that pops up and select a color you think is appropriate. Note how you can drag the cross symbol among the various hues to choose one. Then click OK.

Answers

Problem 2
You use OR because AND would look for a data record whose name was both Modoc Medical Center and Tri City Hospital, and this does not exist.
About 975 km

Problem 3
About 30.578 ha

Problem 4
Just over 12 km