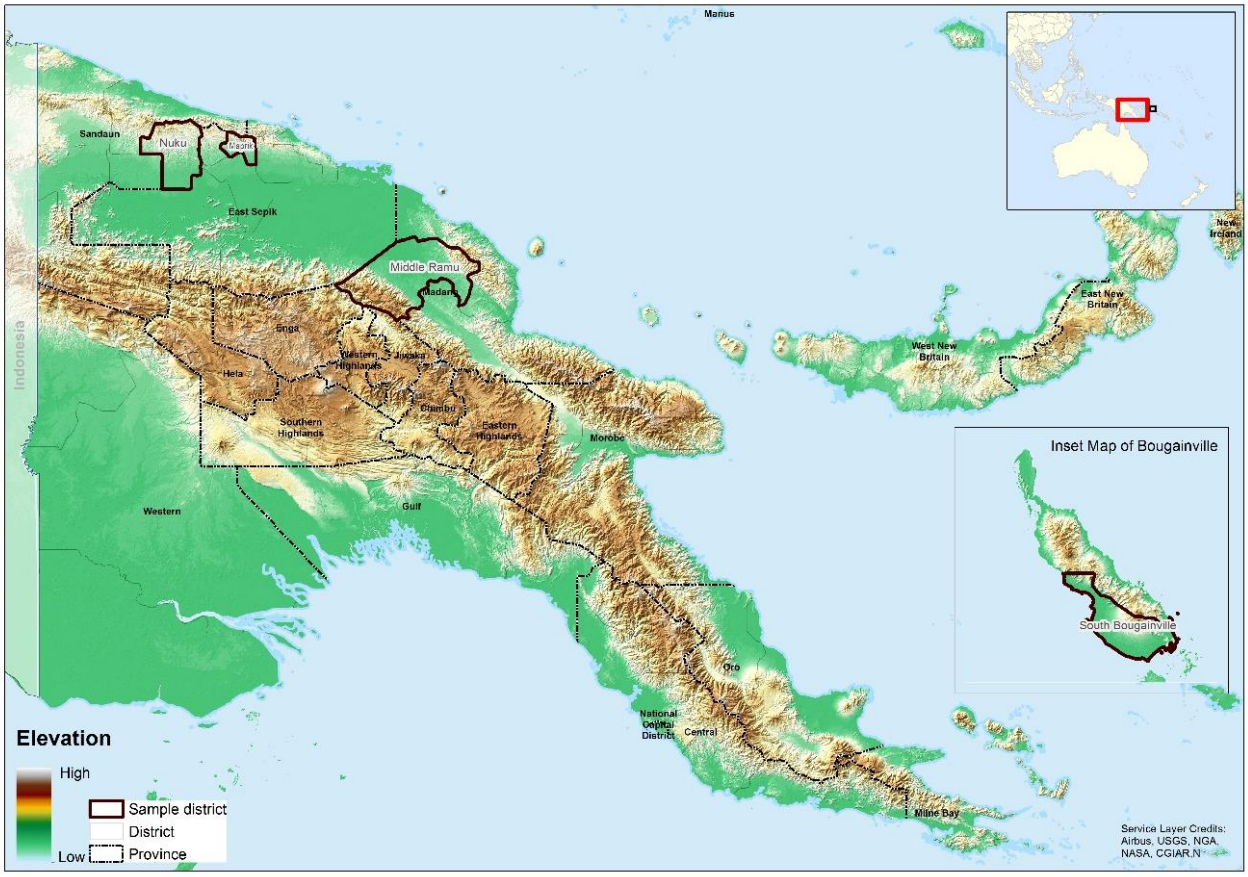
Introduction to Geographic Information Systems (GIS)
& Mapping Agriculture System



Department of Agriculture and Livestock, POM, PNG

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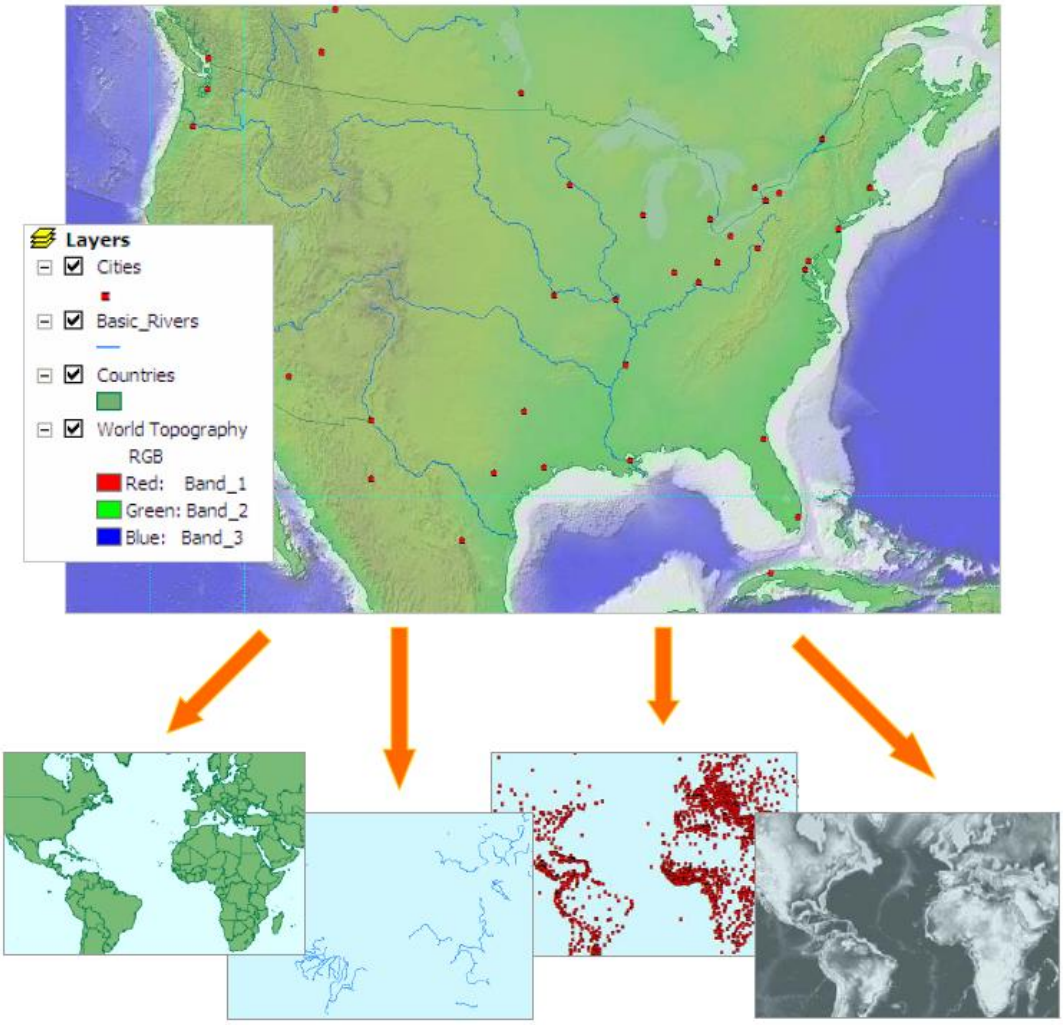
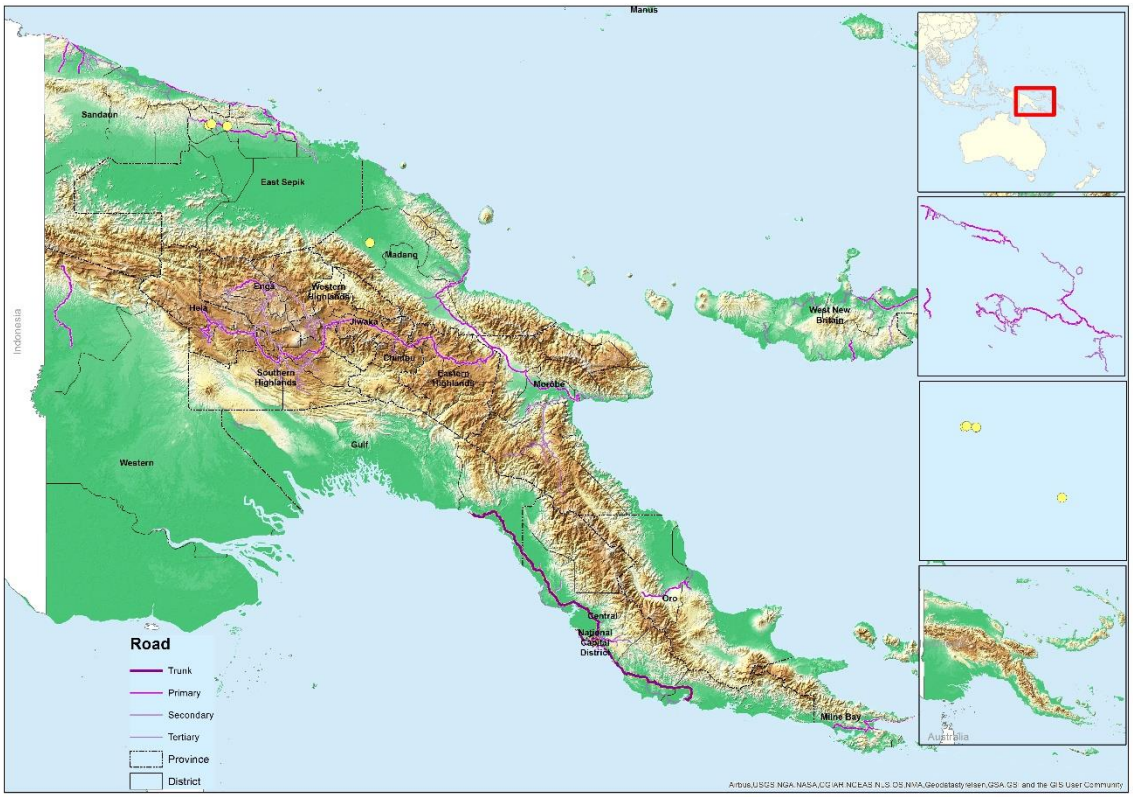
Exercise 01 – Introduction

Introduction - Basic Principles of GIS

GIS is a technology used to view and analyze data from a geographic perspective.
GIS links location to information, and layers that information to give a better understanding of how it interrelates. A GIS map is therefore composed of many layers, or collections of geographic objects that are alike. You choose what layers to combine based on your purpose. The following map contains four layers, Cities, Rivers, Countries, and Topography (elevation data).
Remember: A **Map** is made up of **Layers**



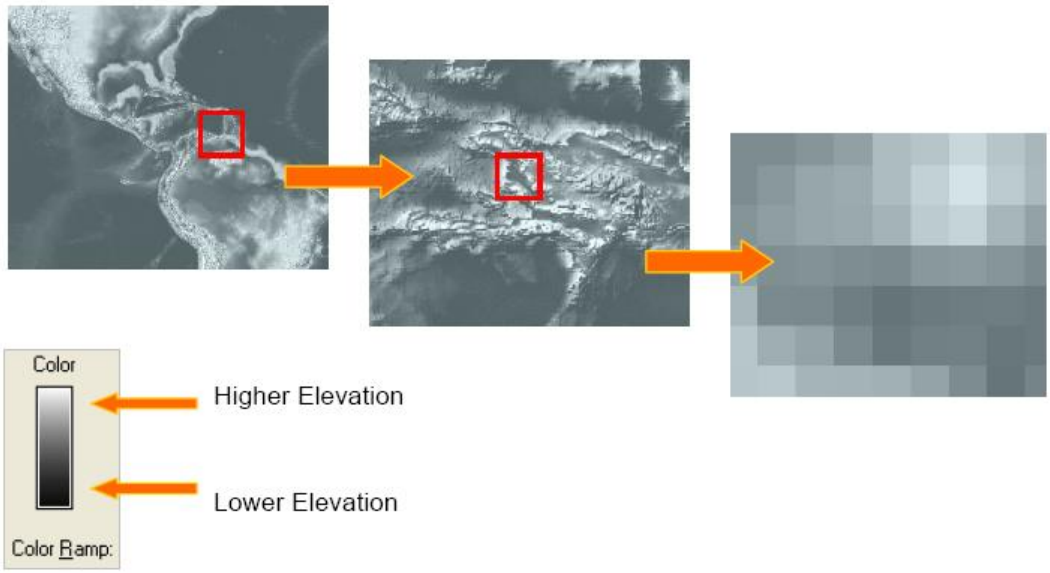


In the preceding map, the “Field visit sites” layer is made up of many different visited sites, and the “Road” layer of many different road types. The same is true of the “Provinces” layer. Each geographic object in a layer, - each field visit sites, road and provinces – is called a **Feature**.
Remember: **Layers** contain **Features**

In any GIS software, geographic features are represented as one of three geometrical forms, *a polygon, a line, or a point*. Polygons represent things large enough to have boundaries, such as countries, lakes or other large tracts of land. Lines represent narrow, linear features, such as roads, rivers or pipelines. Points are used for things too small to be represented as polygons, such as cities on a map of the United States, or schools on a map of DC. Polygons, lines and points are collectively called **Vector Data**.
Remember: **Features** can take the form of **Points, Lines** and **Polygons,** and are known collectively as **Vector Data.**

Not all layers contain Features, the topological (shaded relief) layer you see above is not a collection of geographic objects in the same way the other layers are. It is a single continuous expanse that changes from one location to another according to the height/depth of the Earth’s surface. A geographic expanse of this type is called a *Raster*. We use Rasters because unlike rivers, or countries, things such as elevation, temperature, rainfall or wind speed have no distinct shape.
A Raster is a matrix of identically sized square cells or pixels (much like a digital photograph). Each cell represents a unit of surface area, and contains a measured or estimated value for that location. When displaying this information, colors are assigned to the individual pixel values along a ramp scale.

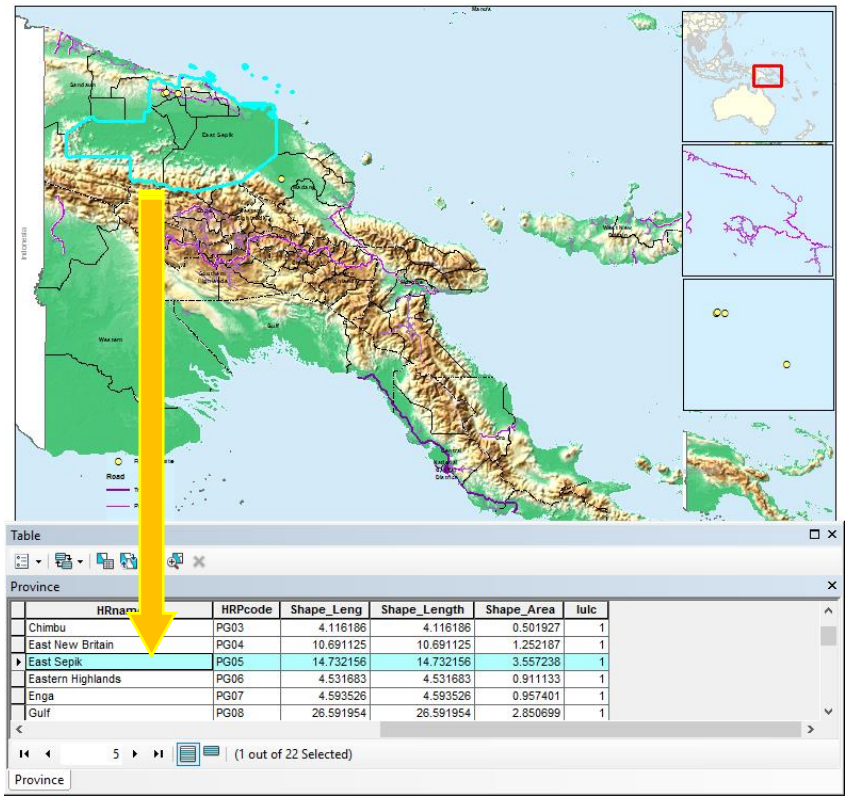
Remember: **Layers** also contain **Rasters**



There is much more to an individual feature than its shape and location, and GIS files have the potential to incorporate this additional information. There is a great amount of information that may be gathered about any one feature. A country has population, a capital, a system of government, leading imports and exports, average rainfall, mineral resources and many other things. Roads have grading systems, speed limits, number of lanes, and one or two-way systems.

Information about the individual feature of any one layer is stored in a table. The table has a record (row) for each feature in the layer, and a field (column) for each category of information. These information categories are called attributes; therefore, these tables are commonly referred to as “Attribute Tables”.
Each object (or “feature”) on a GIS map is linked to a row of information in an attribute table.

Remember: **Layers** contain **Features,** and each **Feature** is linked to a row of information in the **Attribute table**

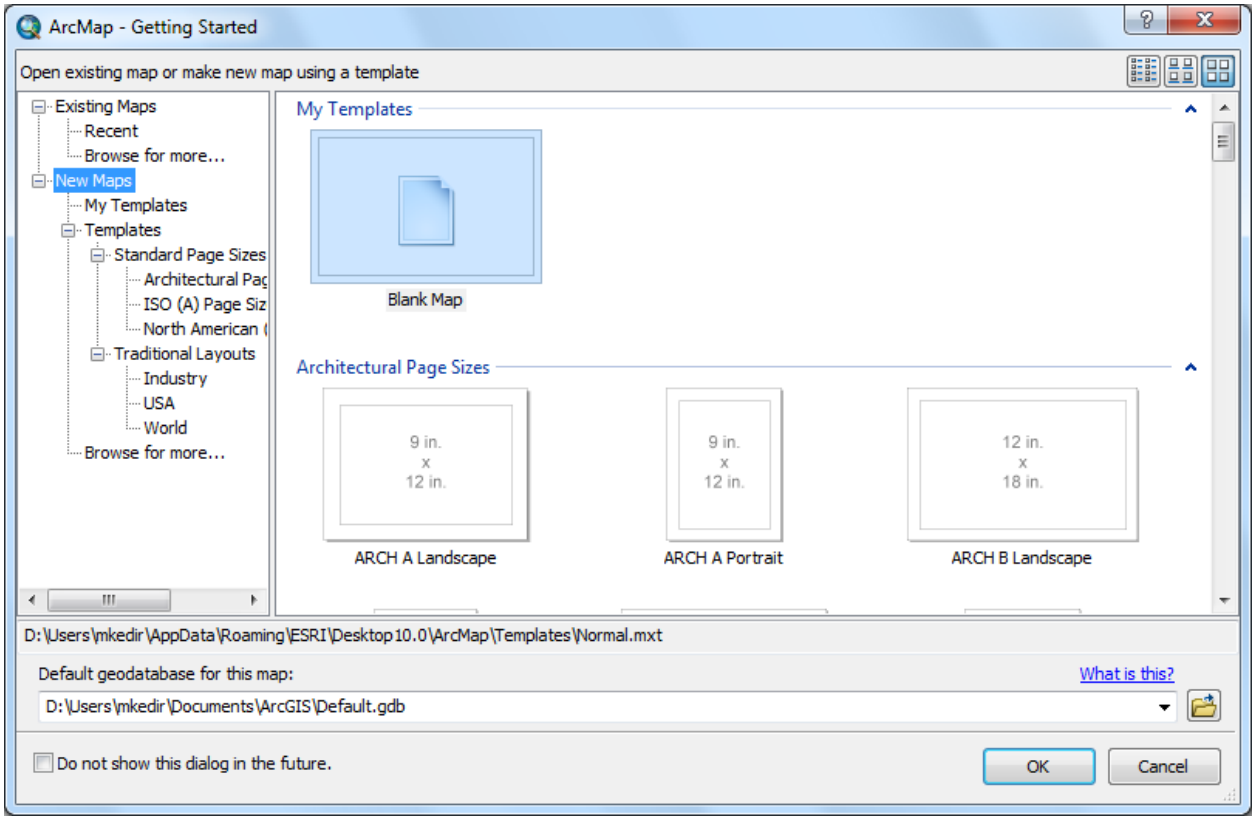


Now, lets get started making our own map!!!

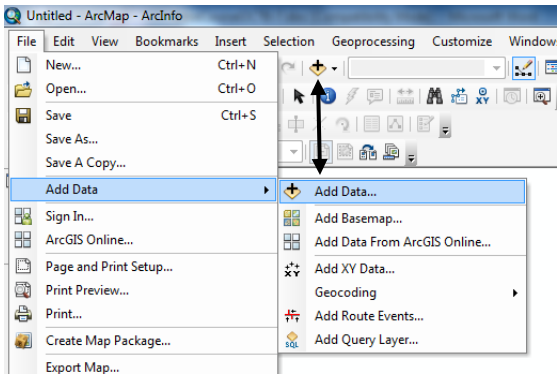
Lab 01 – ArcGIS Basics
The ArcMap Interface & Adding Data

1. Start ArcMap by double-clicking the ArcMap icon on your computer desktop. (Alternately, click the “Start” menu, point to “All Programs”, point to “ArcGIS” and select “ArcMap”)

2. You may receive the following welcome screen, if so, select “a new empty map,” and press OK. If you do not receive this screen, ArcMap has selected a blank map by default.

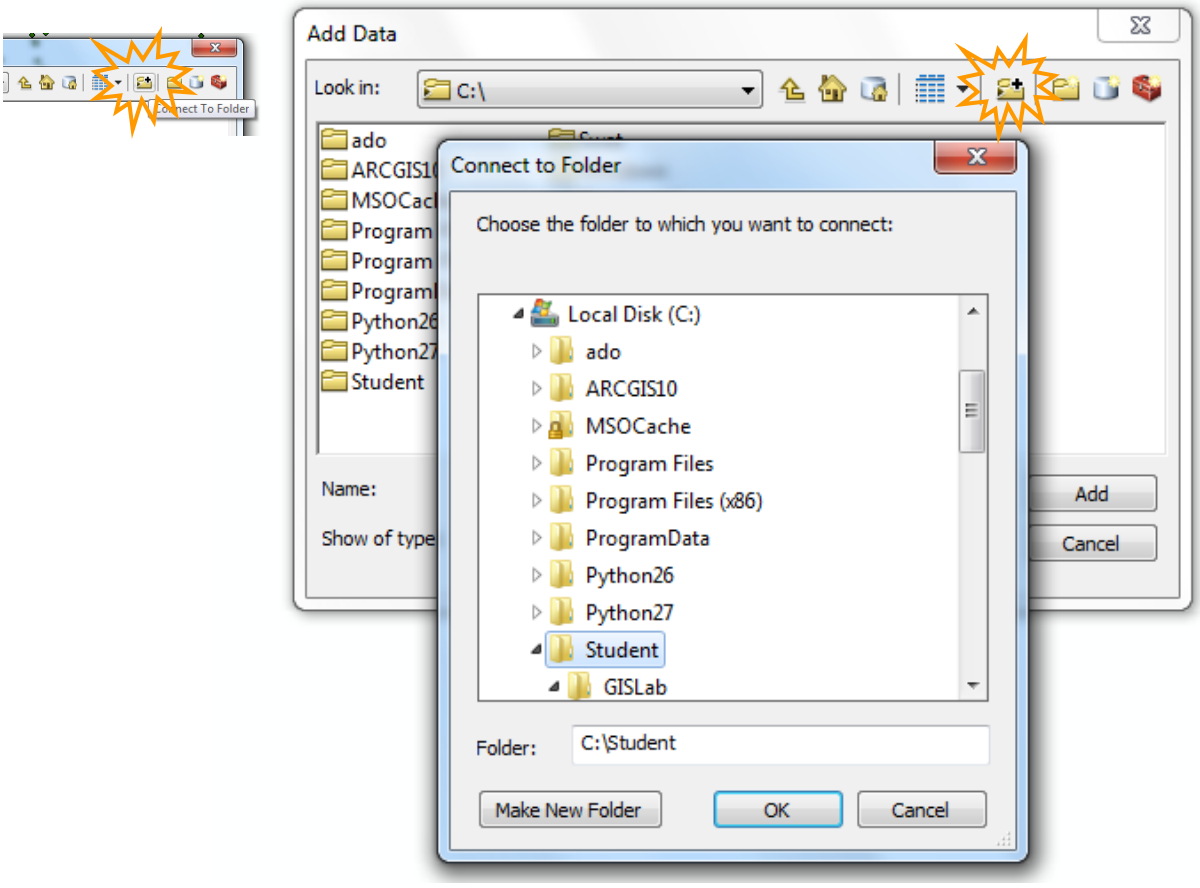


3. You are now looking at the basic ArcMap screen with its various menus and tools. To begin with, we will add some data. From the “File” menu, select “Add Data”. (You will notice that the “Add Data” icon is replicated on the main tool bar. You will find that this is the case for many of the tools and functions within ArcMap.)



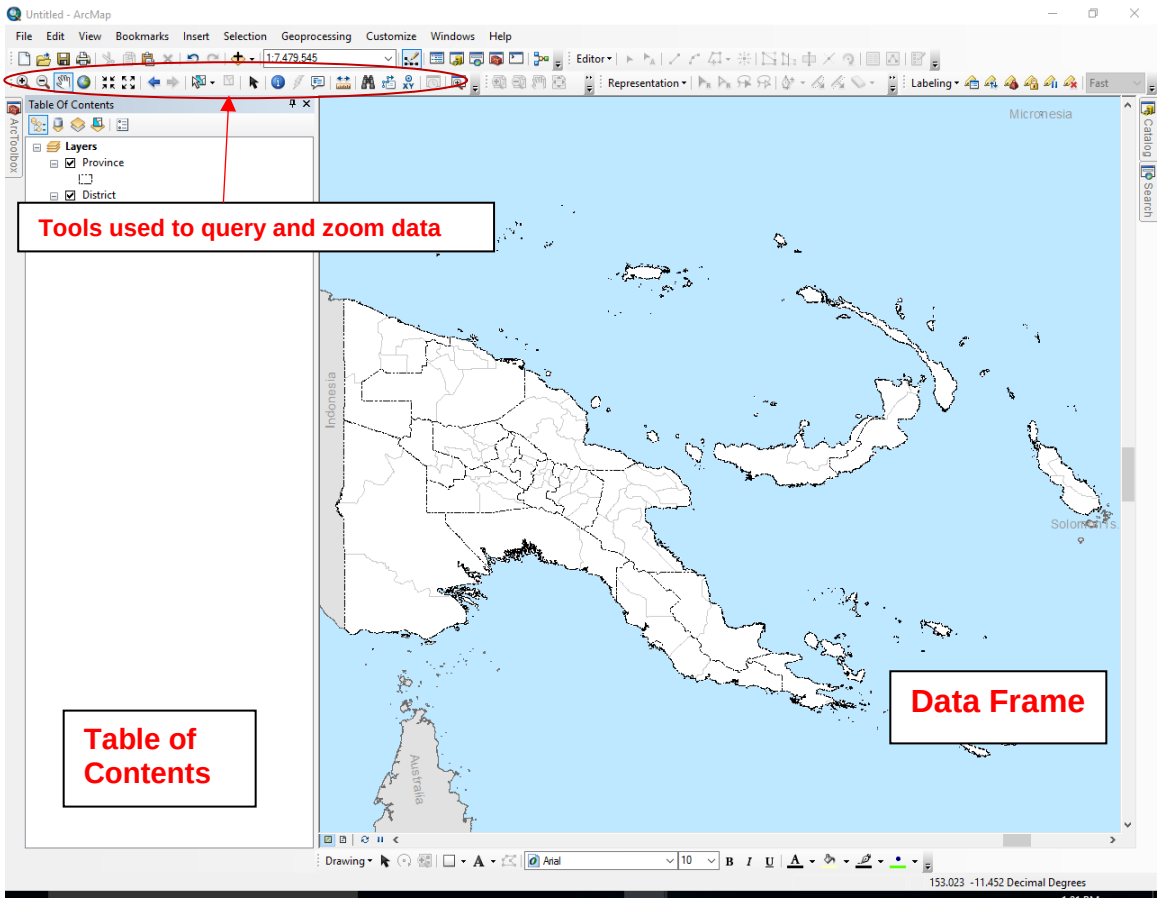
4. In the “Connect to folder” window, navigate to the location of your Tutorial folder: “**C:\Student\GISLab**”, and click OK.

5. You will only have to do this step once. By establishing this connection, you will be directed to your GIS lab folder each time you return to it and add new data to the map. It’s like creating a shortcut.



6. Now open the folder “Lab01”, and select the file named “Province”.

(If a warning box pops up when you attempt to add data at any point, just click OK)



7. The outline of PNG should now be visible in your map window. Notice that on the left hand side of the screen you have a box containing a short list, beginning with the word “Layers.” This box is called the *Table of Contents*, and it lists the names of the various data layers in the map. It shows the color symbol used to draw each layer, and tells you by means of a check mark, whether or not the layer is visible.

8. Left click on the various (+) & (-) boxes in the Table of Contents window, noticing how the Table of Contents changes. It works in a similar way to a data tree within Windows Explorer. Click on the checked box next to the “Province” Layer to turn the layer off, click it again, and the map reappears.

9. The main window of the ArcMap interface is called the *Data Frame*. It is where your data is displayed and manipulated. The various toolbars can be found both above and below the Data Frame. Many of their functions are also replicated in the standard drop down menus to the top left.

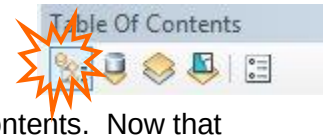
10. In order to make the map more detailed, we will add further layers. Add additional data by using either the “File” menu, or click on the “Add data” icon  . You will be taken back to the “Lab01” folder. Select “Town.shp” and holding down the “ctrl” key select “Rivers.shp”. Click Add. The fact that you now have multiple layers in your map is represented in your Table of Contents. Make sure that you see the

"Provinces", "Towns", "Rivers" shapefiles in your Table of Contents on the left of your screen.

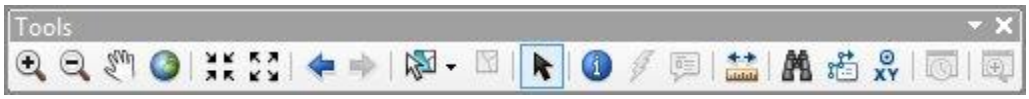
Navigation using the ArcMap Toolbars

11. Hold down your left mouse button over "Towns.shp" and drag it down below your "Provinces.shp" file. What happened to your map? The Table of Contents window controls the various layers of your map. Whichever layer is on top in the Table of Contents, will also be the topmost layer of your map. Move the other layers around to see how this property works.

IMPORTANT NOTE: In order to drag files to reorder them, your table of contents must be in the List by Drawing Order mode, look at the top of the table of contents and make sure that the List by Drawing Order tab is selected. Click on the List by Source tab at the top of the Table of Contents. Now that you are in this tab, you can see where each data source came from. Try to reorganize your shapefiles so "Provinces" is on the top again. Notice that you cannot move the order of your shapefiles unless you are in the List by Drawing Order mode tab. Click on the List by Drawing Order mode tab again at the bottom of your Table of Contents in order to change order of your shapefiles in the Table of Contents.



12. On your screen are various tool icons. By moving your mouse over each icon in turn, a pop-up box will alert you to the name and/or function of that particular tool. Many of the tools, though new, are self-explanatory, and many others, such as the "Drawing" tools, are quite similar to those found in basic Windows programs. The most basic toolbar within ArcMap contains the navigational tools:



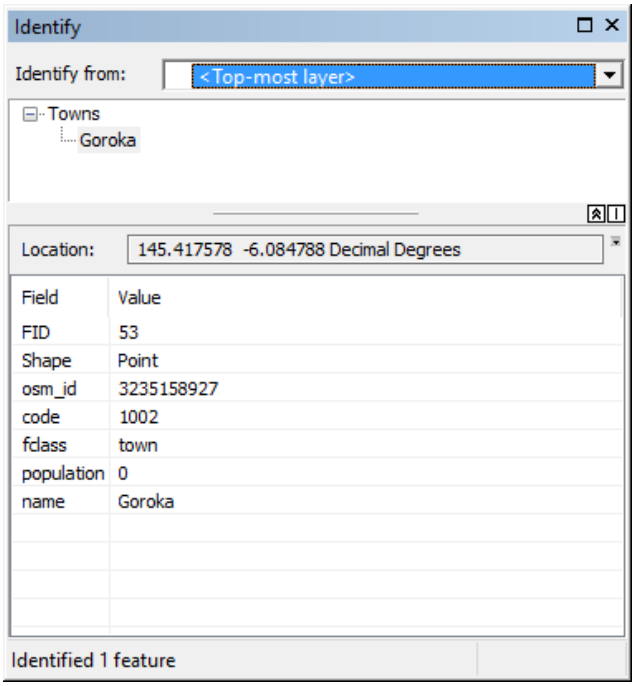
13. Locate the "Zoom In" tool  . Using this tool, draw a box around Lae city by left click and hold while you draw a box. Now, select the tool that looks like a hand  . This is called the "Pan" tool. Use it to 'grab' the map and move it around in order to see other areas of your map.

14. On your toolbar, you will see the scale box. 

15. Using the "zoom in" / "zoom out"  or the "fixed zoom in" / "fixed zoom out" Tools  , adjust the map until your scale shows approximately "1:7,000,000". You may also manipulate the scale box by directly typing the required scale.

16. Switch to the identify tool  and click on any one of the diamonds representing the towns. The "Identity Results Dialog" shows you various facts about the feature that

you have selected. Using the Identify tool, you can see the information associated with each town in the pop-up dialog.



17. Now click on the tool called “Full Extent”.  This resizes your map to cover the full area of your largest feature (all of PNG).

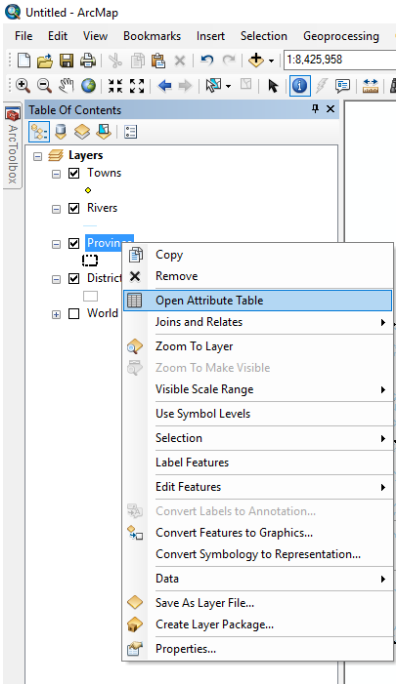
18. Click on the tool for “Previous Extent”  and it will take you back to your last zoomed in view.

Now that we have explored a little on how to maneuver the basic tools in the map viewer format, we will now look at the data that are behind the shapefiles, these data are very similar to an excel table.

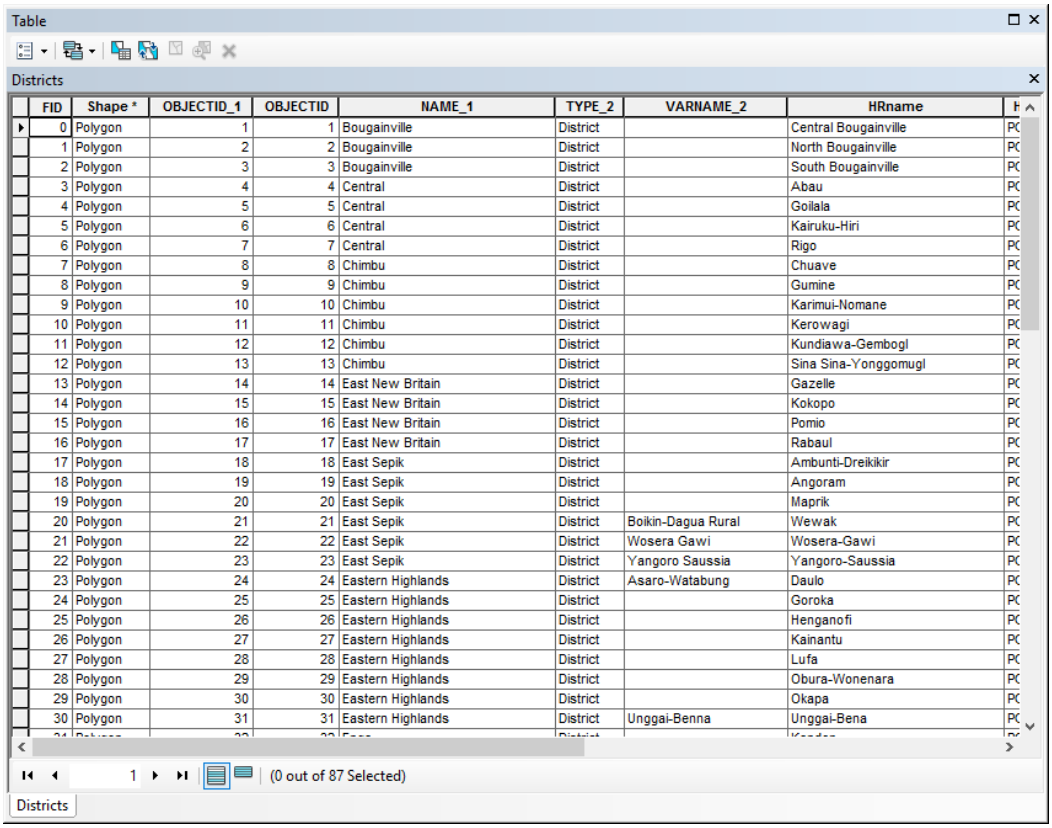
Feature Attribute Tables

In GIS, a feature on a map may be associated with a great deal of information – more than can be displayed at any given time. This information is stored in an **Attribute Table**. A data layer’s attribute table contains a row (or record) for every feature in the layer and a column (or field) for every attribute, or category of information. When you clicked on one of the ‘Town points in Step 16 (above), the information you saw in the identify results dialog was the information stored in the **Attribute Table** for the “Towns” Layer.

19. . Click on the “Add data” icon. You will be taken back to the “Lab01” subfolder. Select Districts.shp” and click “Add”. You may have a warning message pop up, just press the OK tab; we will cover this in the next lab. In the table of contents, right click on the new data layer “Districts.shp” and click the option “Open Attribute table”.



20. Scroll down the table. There are 87 records (record one is numbered as 0 – see first observation in the table under column heading FID), one for each district in PNG.

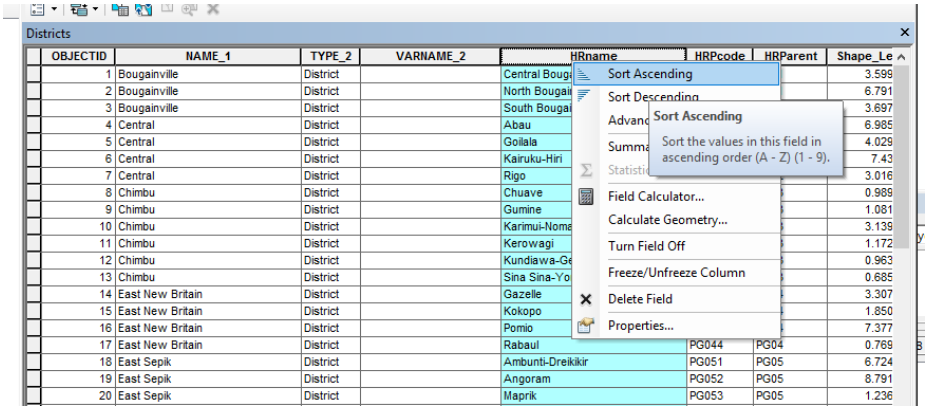


FID	Shape *	OBJECTID_1	OBJECTID	NAME_1	TYPE_2	VARNAME_2	HRname	H
0	Polygon	1	1	Bougainville	District		Central Bougainville	PC
1	Polygon	2	2	Bougainville	District		North Bougainville	PC
2	Polygon	3	3	Bougainville	District		South Bougainville	PC
3	Polygon	4	4	Central	District		Abau	PC
4	Polygon	5	5	Central	District		Goilala	PC
5	Polygon	6	6	Central	District		Kairuku-Hiri	PC
6	Polygon	7	7	Central	District		Rigo	PC
7	Polygon	8	8	Chimbu	District		Chuave	PC
8	Polygon	9	9	Chimbu	District		Gumine	PC
9	Polygon	10	10	Chimbu	District		Karimui-Nomane	PC
10	Polygon	11	11	Chimbu	District		Kerowagi	PC
11	Polygon	12	12	Chimbu	District		Kundiawa-Gembogl	PC
12	Polygon	13	13	Chimbu	District		Sina Sina-Yonggomugl	PC
13	Polygon	14	14	East New Britain	District		Gazelle	PC
14	Polygon	15	15	East New Britain	District		Kokopo	PC
15	Polygon	16	16	East New Britain	District		Pomio	PC
16	Polygon	17	17	East New Britain	District		Rabaul	PC
17	Polygon	18	18	East Sepik	District		Ambunti-Dreikikir	PC
18	Polygon	19	19	East Sepik	District		Angoram	PC
19	Polygon	20	20	East Sepik	District		Maprik	PC
20	Polygon	21	21	East Sepik	District	Boikin-Dagua Rural	Wewak	PC
21	Polygon	22	22	East Sepik	District	Wosera Gawi	Wosera-Gawi	PC
22	Polygon	23	23	East Sepik	District	Yangoro Saussia	Yangoro-Saussia	PC
23	Polygon	24	24	Eastern Highlands	District	Asaro-Watabung	Daulo	PC
24	Polygon	25	25	Eastern Highlands	District		Goroka	PC
25	Polygon	26	26	Eastern Highlands	District		Henganofi	PC
26	Polygon	27	27	Eastern Highlands	District		Kainantu	PC
27	Polygon	28	28	Eastern Highlands	District		Lufa	PC
28	Polygon	29	29	Eastern Highlands	District		Obura-Wonenara	PC
29	Polygon	30	30	Eastern Highlands	District		Okapa	PC
30	Polygon	31	31	Eastern Highlands	District	Unggai-Benna	Unggai-Bena	PC

21. There are multiple attributes, or fields. The “FID” field contains a unique identification number for every record. The “SHAPE” field describes the object geometry (Point, Line, Polygon). Among other attributes is the District name (HRname), its corresponding District code (HRPcode).

22. The order in which the fields are displayed can be rearranged, much like in excel. Click once on the field name in order to highlight it, then, click a second time (you should see a white arrow), to drag it to your preferred location. Rearranging the data like this has no adverse effects on the database or map.

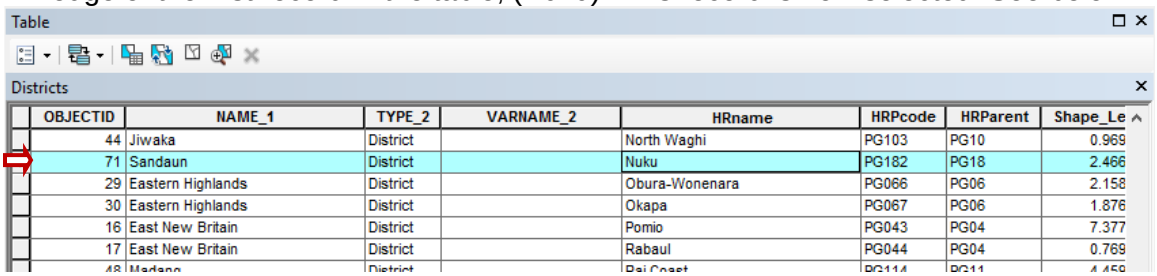
23. Field data may also be sorted. Right Click on the field “HRname”. You will have option to sort “Ascending” or “Descending”. Depending on the field type, the data will be sorted in alphabetical or numerical order. Sort and resort this field and observe the effects on the table arrangement.



OBJECTID	NAME_1	TYPE_2	VARNAME_2	HRname	HRPcode	HRParent	Shape_Le
1	Bougainville	District		Central Bougi			3.599
2	Bougainville	District		North Bougai			6.791
3	Bougainville	District		South Bougai			3.697
4	Central	District		Abau			6.985
5	Central	District		Goilala			4.029
6	Central	District		Kairuku-Hiri			7.43
7	Central	District		Rigo			3.016
8	Chimbu	District		Chuave			0.989
9	Chimbu	District		Gumine			1.081
10	Chimbu	District		Karimui-Noma			3.139
11	Chimbu	District		Kerowagi			1.172
12	Chimbu	District		Kundiawa-Ge			0.963
13	Chimbu	District		Sina Sina-Yo			0.685
14	East New Britain	District		Gazelle			3.307
15	East New Britain	District		Kokopo			1.850
16	East New Britain	District		Pomio			7.377
17	East New Britain	District		Rabaul	PG044	PG04	0.769
18	East Sepik	District		Ambunti-Dreikikir	PG051	PG05	6.724
19	East Sepik	District		Angoram	PG052	PG05	8.791
20	East Sepik	District		Maprik	PG053	PG05	1.236

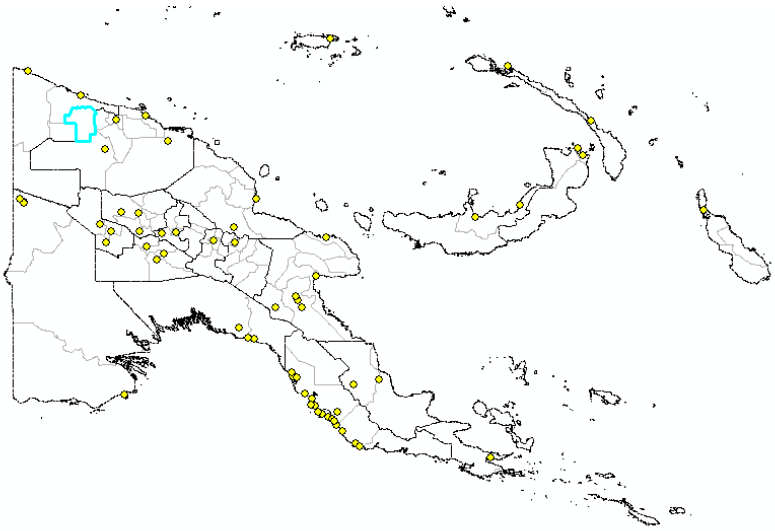
24. Records, as well as fields can be highlighted. When a record is highlighted in a table, its corresponding feature is highlighted in the map. A highlighted record or feature is said to be “Selected”.

25. Right click on the field “HRname” and Sort Ascending. Click the grey tab at the left edge of the first record in the table, (Nuku). This record is now selected. See below.



OBJECTID	NAME_1	TYPE_2	VARNAME_2	HRname	HRPcode	HRParent	Shape_Le
44	Jiwaka	District		North Waghi	PG103	PG10	0.969
71	Sandaun	District		Nuku	PG182	PG18	2.466
29	Eastern Highlands	District		Obura-Wonenara	PG066	PG06	2.158
30	Eastern Highlands	District		Okapa	PG067	PG06	1.876
16	East New Britain	District		Pomio	PG043	PG04	7.377
17	East New Britain	District		Rabaul	PG044	PG04	0.769

26. Move or minimize the attribute table in order to see the map more clearly. The Nuku district should be highlighted. You may have to use the “Zoom to Full Extent”  to spot the selected district.



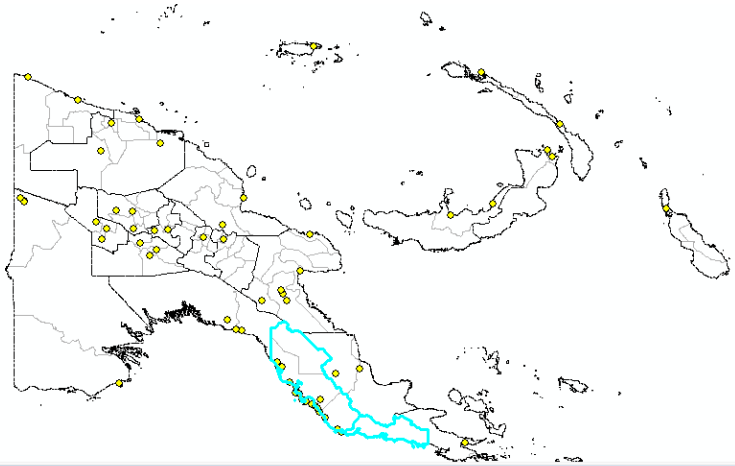
27. To unselect this record, click the “Table Options” dropdown  on the top left-hand side of the attribute table, or and click “Clear Selection” OR click  tab.

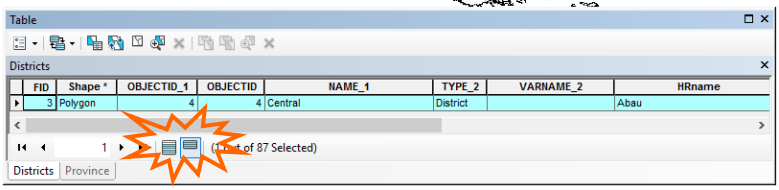
28. You can also select objects in ArcMap directly from the map window. Close the attribute table for now. Pan to the South Eastern Area, and select a district using the following “selection” tool from the main toolbar. 

29. Reopen the attribute table for “District.shp”. On the bottom-center of the attribute table, click on the button “selected”. The district you selected should appear as the only records in this list.

See how the link between table and map works; Items selected in the map are also selected in the table, and visa versa. When you select a district, and you see that more is being highlighted than just the district, this is because the select tool selects the related area with each area file in the table of contents.

So, not only did you select Abau district, but you also selected Central province. You can open the Province Attribute table and click on the “show selected records” tab, you will see that Central province is selected.





30. To unselect this record, Select the “Clear Selection” tab on the top of attribute table, and click “Clear Selection”.(As shown below)

Now unselect this record by selecting the “Clear Selection” tab on the top the Attribute table, and click “Clear Selection”. Close the attribute table. If you still have an area that seems selected on your map, you can use the “Clear Selected Feature” button  to unselect everything in the Data Frame.

Symbolizing Features

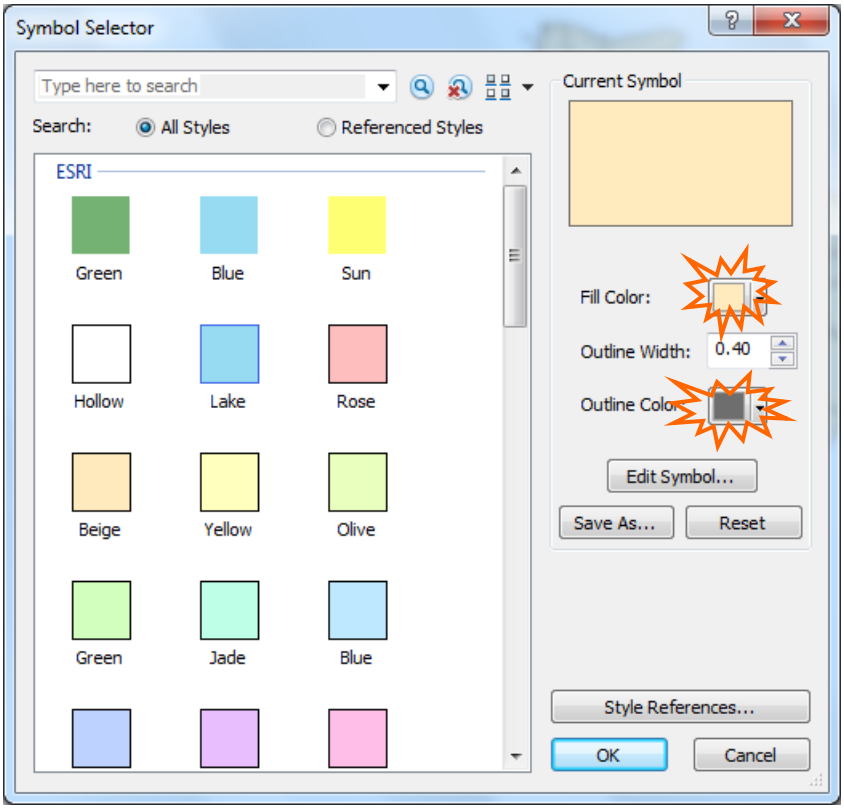
Symbolizing features means assigning them colors, markers, sizes, widths, patterns, transparency and other properties by which they can be recognized on a map. Data Layers added to Arc Map have default Symbology. Points are displayed with small circles or diamonds, and polygons (or shapes) have a fill color and outlines. The colors for points, lines and polygons are randomly chosen.

31. First, turn off the “Districts” layer, by clicking the little black check mark to the left of the layer name “Districts”.

32. Then, use the “Zoom to Full Extent”  button to return to a view of entire PNG. In the Table of Contents, double-click on the color symbol for “Provinces” layer. The 

Symbol Selector dialog opens.

33. The scroll box on the left contains predefined symbols. The options frame on the right allows you to pick specific colors and set outline widths. Choose a color of your preference for both Fill and outline.



34. Next, we will work on the Symbology for the Towns. In the table of contents, double click on the point symbol for the “Towns” layer. The Symbol Selector dialog opens once again. In the scrolling box of predefined point symbols, click “Circle 1”. In the “Options” frame, click the drop-down arrow to change the symbol size to 4 points. Again, choose your color preference. On the map, the Towns should display with your new symbol.

35. Choose a new color for the “River” layer also by double clicking on the line symbol underneath the layer in the Table of contents, as you did for the “Districts” and “Towns”.

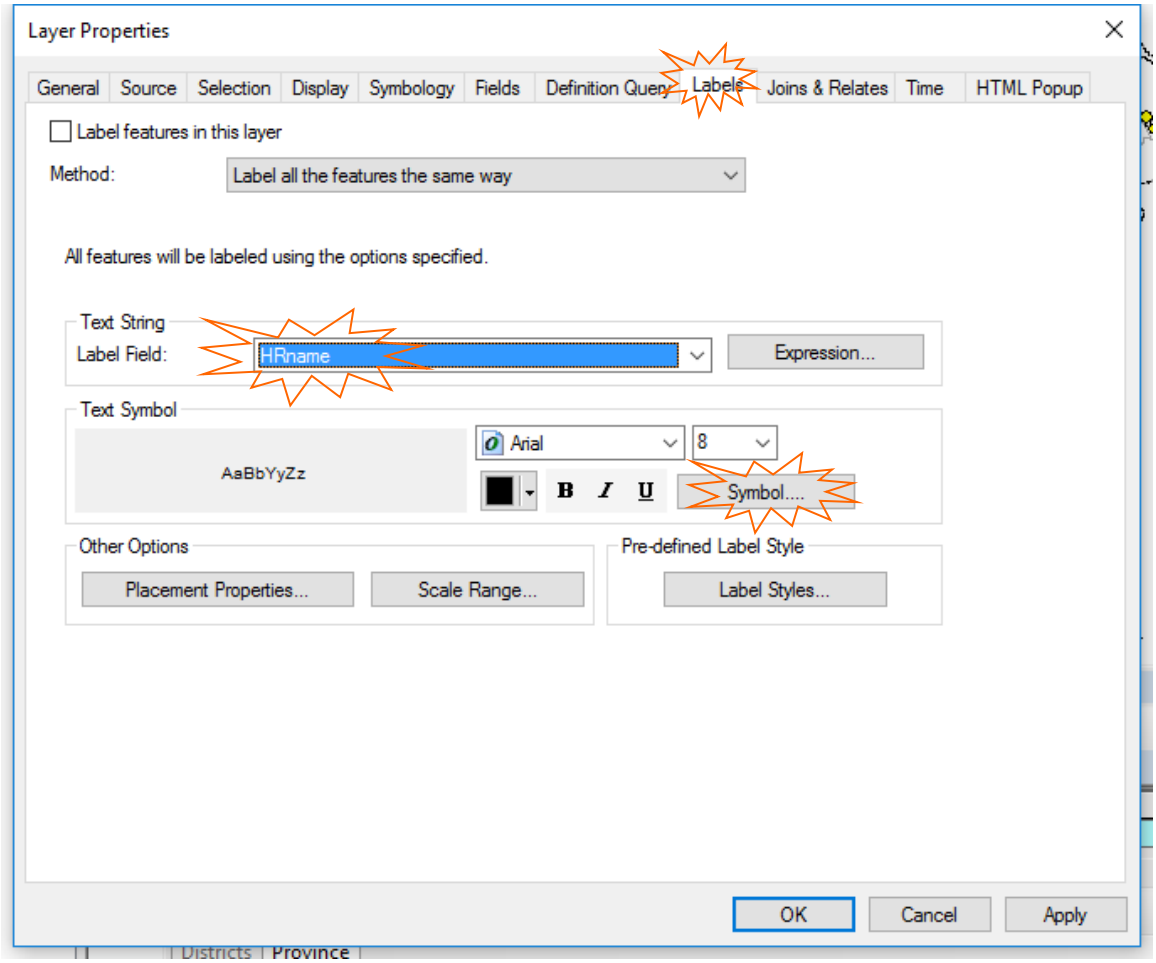
36. Experiment with the colors and options for the various layers. You are not tied to those suggested by this lab.

Labeling: *All maps contain textual information. Features in ArcMap are identified with labels that make use of information from fields in the Attribute table to identify a particular set of features.*

37. For the moment, turn off your “Towns” and your “Rivers” layer.

38. Double left click on the “Provinces” layer, The pop-up window you now see is called the “Layer Properties” dialog. The mapmaker controls many properties of an individual layer from this dialog, and we will work with this quite regularly in the future, but for the moment, click on the “Labels” tab and thick the “label features in the layer” (see below)

39. Click on the arrow for the drop down menu on the Label Field option, and choose “HRname”



41. Using the text tools, change the label to bold size 8. For more advanced options, Click on the button “Symbol”, then the button “Properties”, and finally the tab “Mask”. This will allow you to put a halo on your text. Choose a white halo, of 1.5 points.

Click OK repeatedly to accept these changes and exit out of the Layer Properties dialog. You are encouraged to explore the other tabs within the labeling function at your leisure. For example, you can explore the “Label Styles” under Pre-defined Label Style to see different sizes of text and shadowing styles.

Saving your Progress

At this point, you have changed and customized quite a few features of this map. In order to preserve these changes, we will now save your progress as a “Project file”. A project file in ArcMap carries the file extension .mxd. An .mxd file saves each component of a working map, from the files you have opened, to the colors you have chosen. This allows you to edit and return to a particular map, repeatedly.

42. From the “File” menu in the top left corner of your screen, choose “Save As”. Navigate to the GIS folder on the C: drive; C:/Student/GISLab/Lab01, and save as “Lab01_”Yourname”.mxd. It is always a good idea to save your map repeatedly while working.

The Layout View

43. You now have a basic GIS map of PNG. The next step is to prepare this map for printing.

44. First, make sure that your “Provinces”, “Towns”, and “Rivers” shapefiles are all turned on by checking the checkmark box next to the layer name in the table of contents.

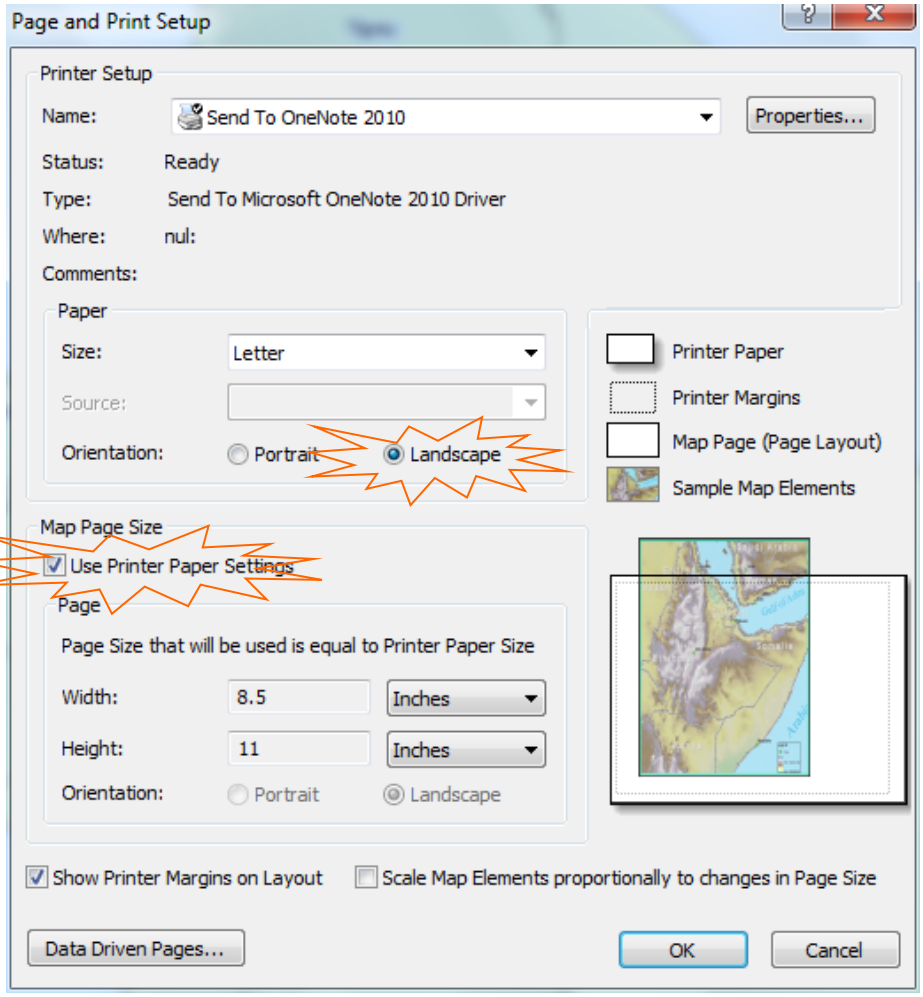
45. The map window that you have been working in up to now is called the “Data View”. We will now move to a different map window called the “Layout View” to prepare the map for printing. The “Data View” is where you perform the majority of your GIS editing work, while the “Layout View” is where you arrange your map(s) along with preferred graphics for printing or export. To navigate between these two views, there are two small tabs located on the bottom left-hand corner of the main map window.

46. The “Layout View” is represented by the sheet of paper map, and the “Data View” by the screen with map. Click over and back between these tabs, and observe the changes.

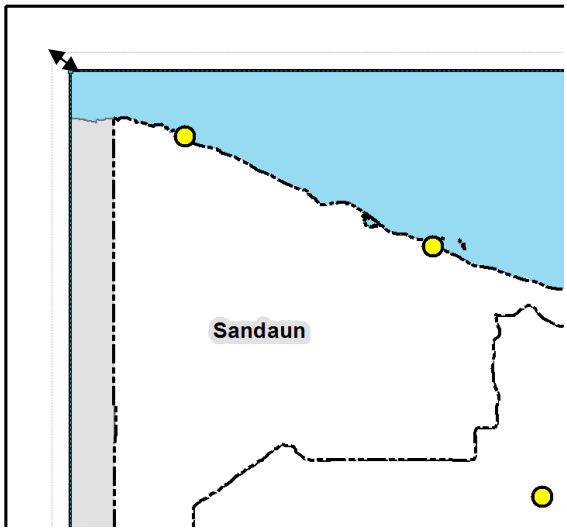
47. The third little icon, represented by the double arrows, is the “Redraw/Refresh” button. Use this button at any time, if you feel your map has not redrawn fully after opening or editing.

48. When you have finished experimenting with the alternative map views, select the layout view.

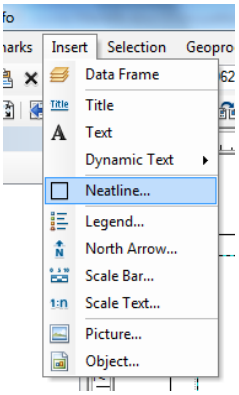
49. We want to select a paper setup that best fits the geographical nature of PNG in order to use the most space on our page for our map. Click on the File tab in the upper left of your screen and scroll to “Page and Print Setup”. Make sure you select Landscape for the Orientation. Also click the checkmark to “Use Printer Paper Settings”. This will give you a dotted outline of how far you are able to expand your map. (see next step)



50. Now, resize the window around your map of PNG, so that it fits within the printable area.



51. Using the “Insert” menu, add a Title, Scale Bar, and North Arrow to your map. Using the insert title option, name your map “PNG: Provinces and Towns” (or something similar).



There are many Scale Bars, and North Arrows styles to choose from. Pick your favorite.

52. Return to the menu option “Insert” and click on “Legend”.

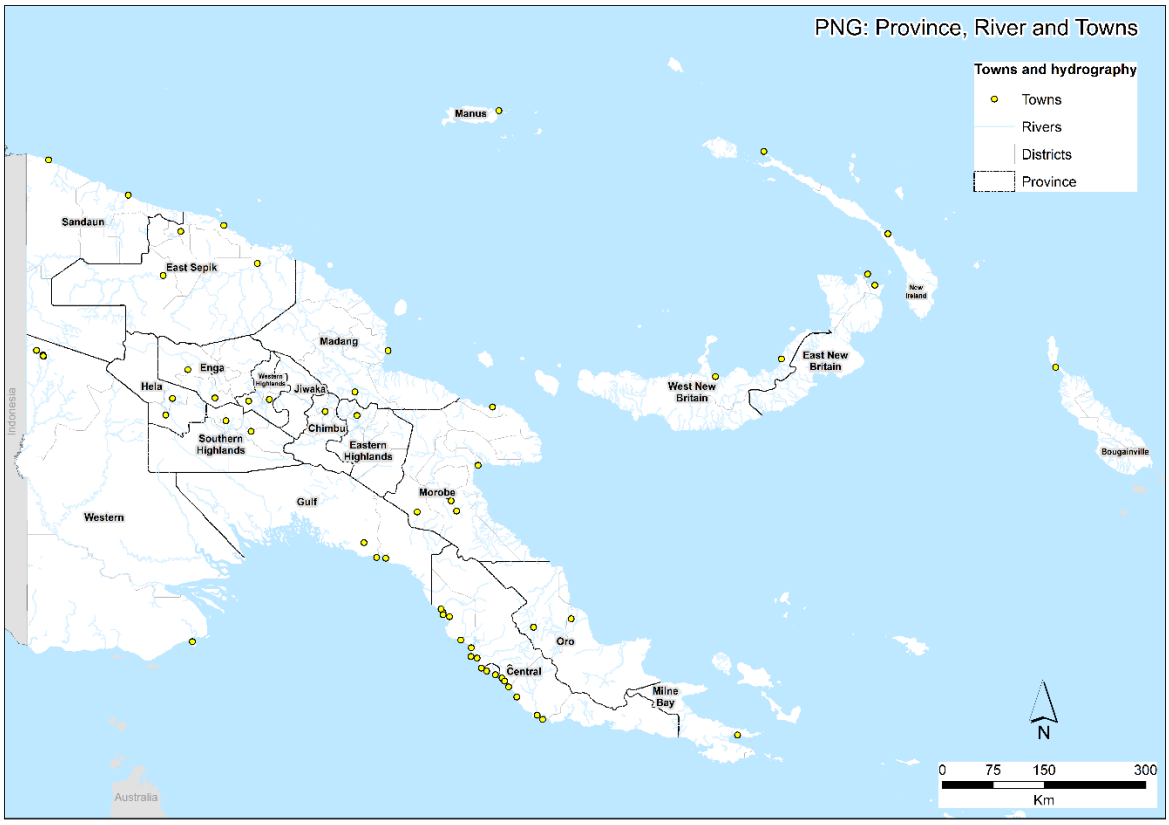
53. In the Legend Wizard dialog that pops up, accept all the default options by Clicking
“Next” repeatedly, and finally “Finish”.

54. You will notice a small legend appear somewhere in the middle of your layout window. Position it correctly.

55. If you wish to change the name of your layers in the legend, edit the corresponding text in the table of contents, and it will also change in the legend. Just click twice on the text in the table of contents to edit it, (as you would to rename a file in Windows Explorer).

56. When you are happy with the appearance of your map, you can export this map as a .jpeg, by choosing the menu option “File”, scroll to “Export”, then save with as (Lab01_YOURNAME.jpeg) in your Lab01 folder following the instructions.

PLEASE MAKE SURE: That you save the changes to your map before you continue. Your map should look similar to the one below (featuring your own color and style preferences of course).


PNG: Province, River and Towns
Towns and hydrography
Towns
Rivers
Districts
Province
Manus
Sandaun
East Sepik
Madang
Enga
Western Highlands
Hela
Jiwaka
Chimbu
Southern Highlands
Eastern Highlands
Morobe
Gulf
Western
Oro
Central
Milne Bay
New Ireland
East New Britain
West New Britain
Bougainville
Indonesia
Australia
N
0 75 150 300
Km

Lab 02: Advanced Symbology

In the previous exercise, Rivers had the same line symbol regardless of their level of importance. This is sufficient for a basic navigational map, but most GIS maps are used as a visual interpretation of tabular data, therefore we will learn how to visualize such data in this lab.

1. Open a new, blank map by clicking on the "New Map" button in the upper left corner of your screen below the "File" button.

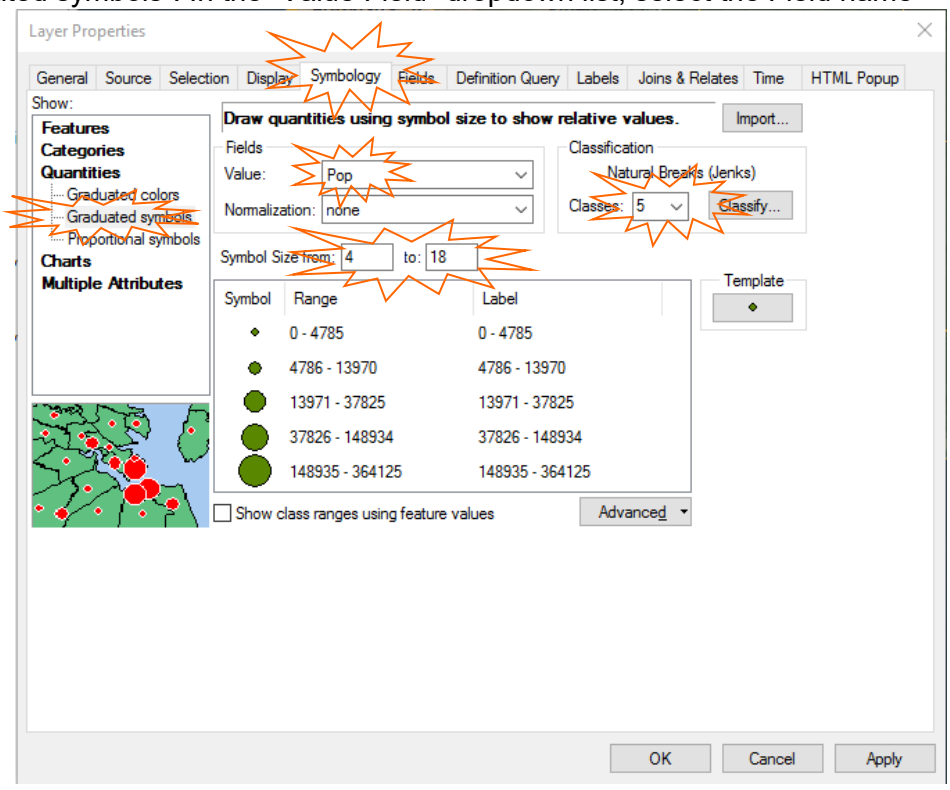
2. From your Lab01 folder, add the file "Province", "Towns" and "Rivers". Reorder these files in the table of contents so that "Towns" are on top, "Rivers" are next, then "Provinces" is at the bottom. **Remember**: Your table of contents must be in the Display mode, look at the bottom of the table of contents and make sure that the Display tab is selected.

3. From your Lab02 folder, add the "Roads" shapefile. Uncheck the roads layer for now so you don't see it in your map frame; we will work on that later. When you uncheck it, the roads layer should disappear from the Data Frame.

4. Choose an appropriate color for the "Provinces" layer, and then SAVE your project file as Lab02_YOURNAME to the Lab02 folder.

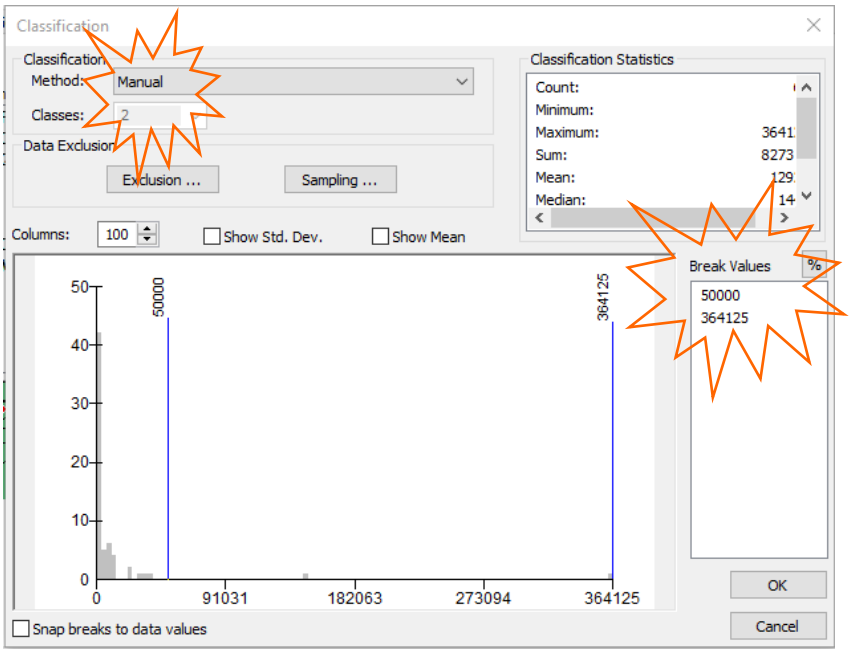
5. Double-click on the layer name "Towns"; this will take you directly to the "Layer Properties" for the layer. Select the tab "Symbology".

6. In the "Show" box (see graphic), click on the option "Quantities", and the sub-option "Graduated symbols". In the "Value Field" dropdown list, select the Field name "Pop".



7. Click “Apply”, but not OK. If you move your dialog slightly you will see that the city symbols have changed. The map is still a little too busy. Change the “Symbol size” to “from: 4 to: 12”.

Next, click on the “Classify” tab. This will take you to the “Classification” drop down menu (see graphic right).

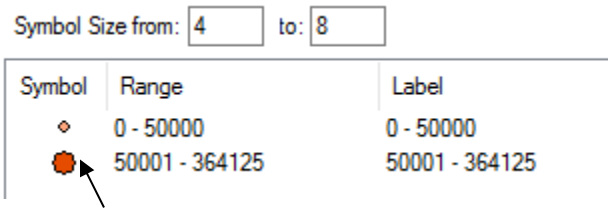


8. Click on the arrow to the right of “Classes” and choose 2. Click on the arrow to the right of “Method” and choose “Manual”.

9. Choose your “Break Values” to be 50,000 and the second the same as it displays the maximum value of population of a town/city. (See right)

10. Press OK once you have finished step 9.

11. Now you are back to the Layer Properties Window. Double-click on the largest circle and chose a bright color to represent the cities that are greater than 50,000 people. Press OK. Double-click on the other circle and chose the symbol “Circle 1” in the left box, change the size to 4 and choose a color for these cities that display population under 50,000.



12. Press OK repeatedly until you see the mapping screen again.

13. Now it should be clearer where the cities of 50,000 are. Switch to your identify tool  , click on one of the large circles. Scroll up and down in the “Identify” window that appears in order to read the attribute information. What is the towns’ name (name)? What is its population (POP)? What is the population (Pop)?

Now, SAVE YOUR WORK again as Lab02_YOURNAME!!

14. Okay, now we are ready to add our roads. Check the box next to your roads layer so it appears in your Data Frame.

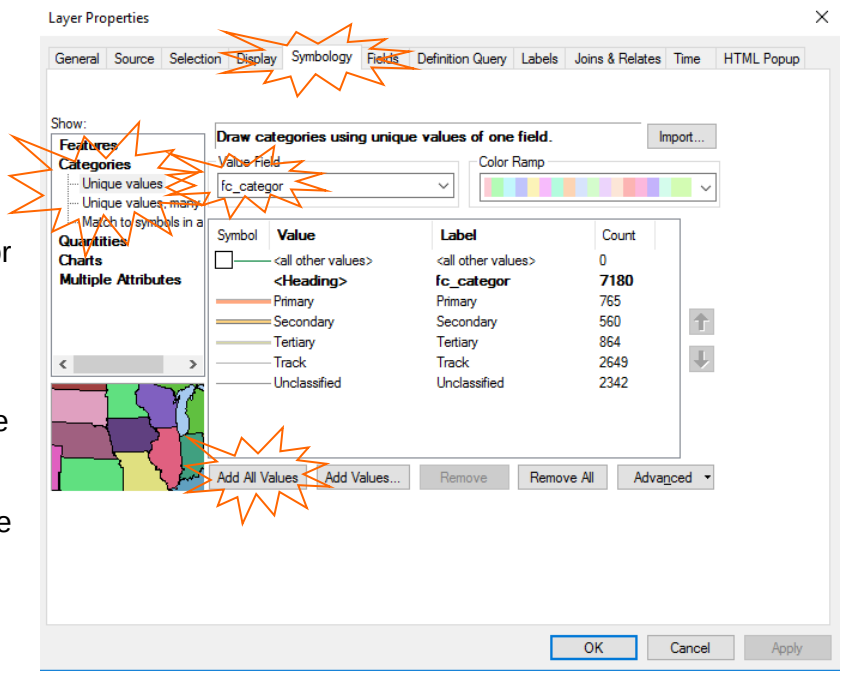
15. The current display shows only road network, this is not very helpful. Double click on the roads layer (double-click on the word ‘Roads’) in order to enter into the “Layer Properties” window. Click on the Symbology tab like you did when you were working on the towns.

16. Click on “Unique Values” under the “Categories” option to the left of the Layer Properties window. (see below)

17. Next, in the drop down menu on the Value Field, choose “fc_categor” and then click on the tab “Add all Values”.

18. Let’s first see how the Primary roads connect to major towns.

19. Double click to the left of the “Primary” on the line symbol, this will take you to the “Symbol Selector” window, choose the “ExpressWay” symbol and press OK. You are now back at the “Layer Properties” window.



20. Now, press “Apply” and move the “Layer Properties” window to the side so you can see your map. Now you are able to see the primary roads more clearly.

21. Now let’s label the other roads more clearly. Double click on the line next to the “Secondary” roads in order to the “Symbol Selector” again. Choose “Major Roads” symbol and press okay. Do the same for the roads labeled “Tertiary”, “Track” and “Unclassified” in order to display them in a different color. Press Apply, and now all roads in your Data Frame should have the colors you chose to display.

21. When you have finished experimenting with the alternative Roads views, **select the layout view (see step 46 in previous exercise if you need help)**.

22. Using the “Insert” menu, add a Title, Scale Bar, and North Arrow to your map.

23. Return to the menu option “Insert” and click on “Legend”.

24. In the Legend Wizard dialog that pops up, except all the default options by Clicking “Next” repeatedly, and finally “Finish”.

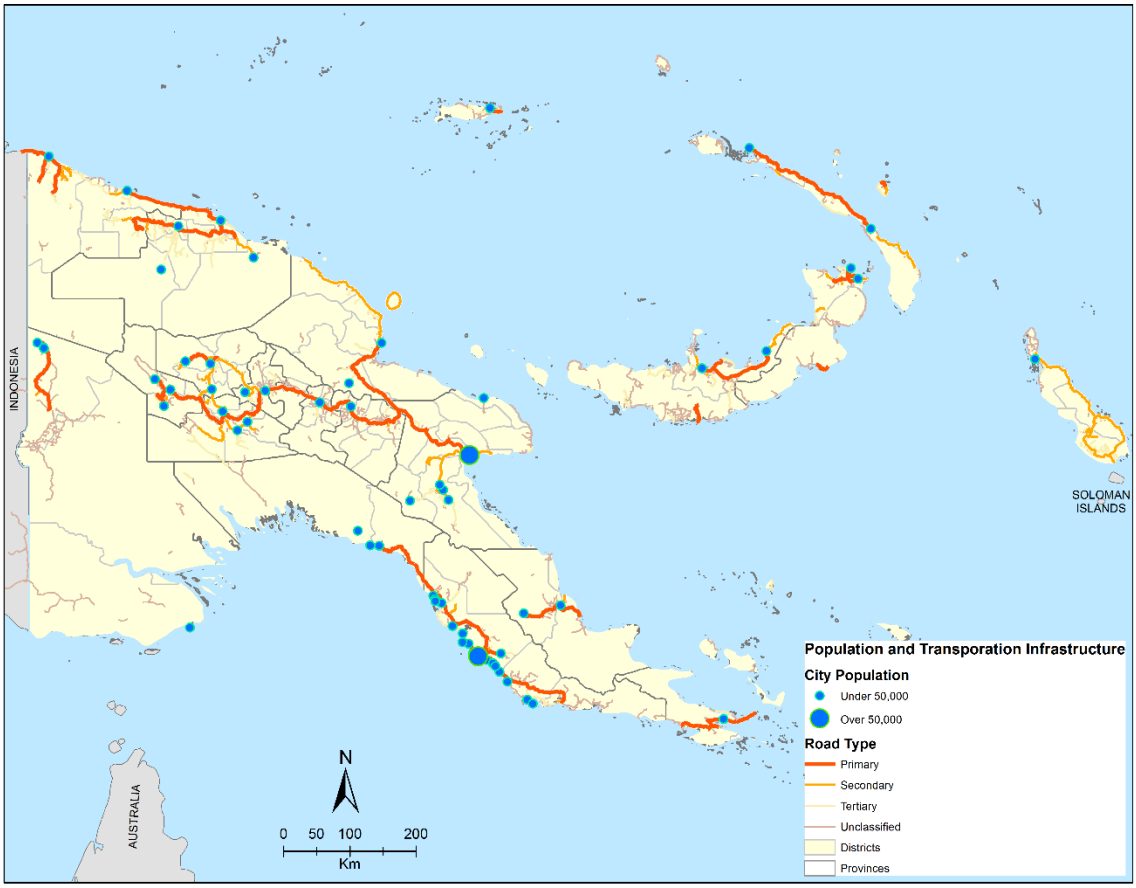
25. You will notice a small legend appear somewhere in the middle of your layout window. Position it correctly.

26. If you wish to change the name of your layers in the legend, edit the corresponding text in the table of contents, and it will also change in the legend. Just click twice slowly on the text in the table of contents to edit it, (as you would to rename a file in Windows Explorer).

27. When you are happy with the appearance of your map, you can export this map as a .jpeg, by choosing the menu option “File”, scroll to “Export”, then save following the instructions.

Your map should look similar to the map below.

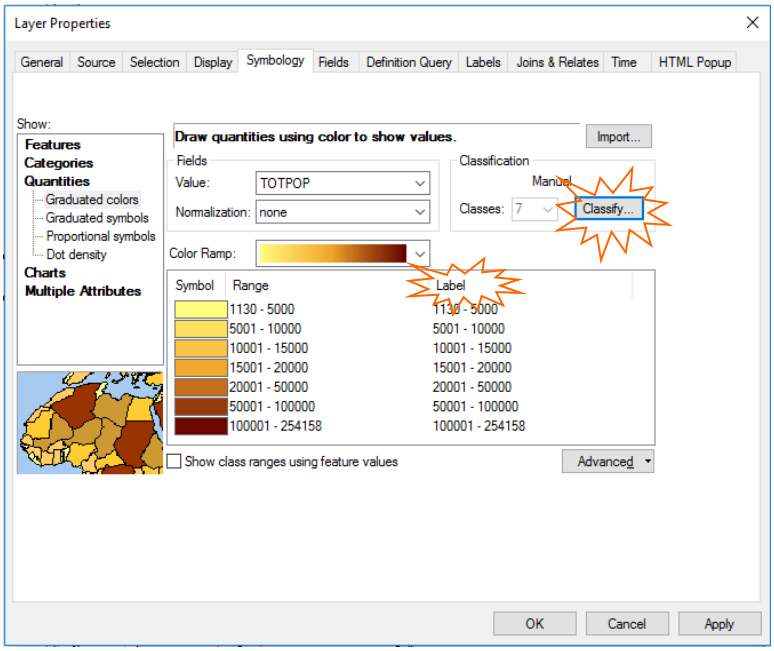
PLEASE MAKE SURE: That you save the changes to your map before you continue.



Lab 03: Chloropleth mapping in Arc-GIS

1. Open a new, blank map by clicking on the “New Map” button in the upper left corner of your screen below the “File” button.

2. From your Labo01 folder, add the “Provinces” shapefile. From your Lab02 folder, add the “Roads” shapefile. From your Lab03 folder add the “LLG_pop_2000” shapefile.

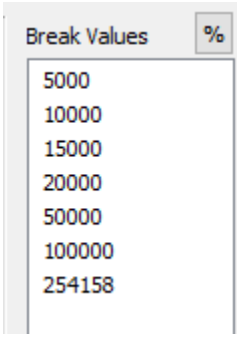


3. Double click on your “LLG_pop_2000” layer in order to open up the “Layer Properties” window. And choose the “Symbology” tab.

4. Click on the “Graduated Colors” under the Quantities option on the left side of the Layer Properties window.

5. Choose TOTPOP in the Value Field, which is the population count per LLG in 2000.

6. Classify your data accordingly by clicking on the “Classify” button and choosing classifications for your values (see step 8 of the previous exercise for help in the specific steps of classifying your data). When finished, press Apply and Okay.



7. Now you are back to the Layer Properties Window. Left click on the numbers under the label column. Here you are able to change the labels of your data so when you make a map, the labels in the legend are clear (see above).

8. Change all of your labels following the graphic above. Then click out of the labels box and press Apply and OK to return to the mapping screen.

9. Make sure that your “Roads” layer is on and that you have classified your roads in hierarchical order.

10. It is interesting to note spatially how population follows critical road infrastructure. But, is population *count* an appropriate measure to understand relationships between infrastructure and demography? Let’s experiment with a different measurement to understand the differences and then create a map of both.

11. Right click on the “LLG_pop_2000” layer name in the table of contents and press copy.

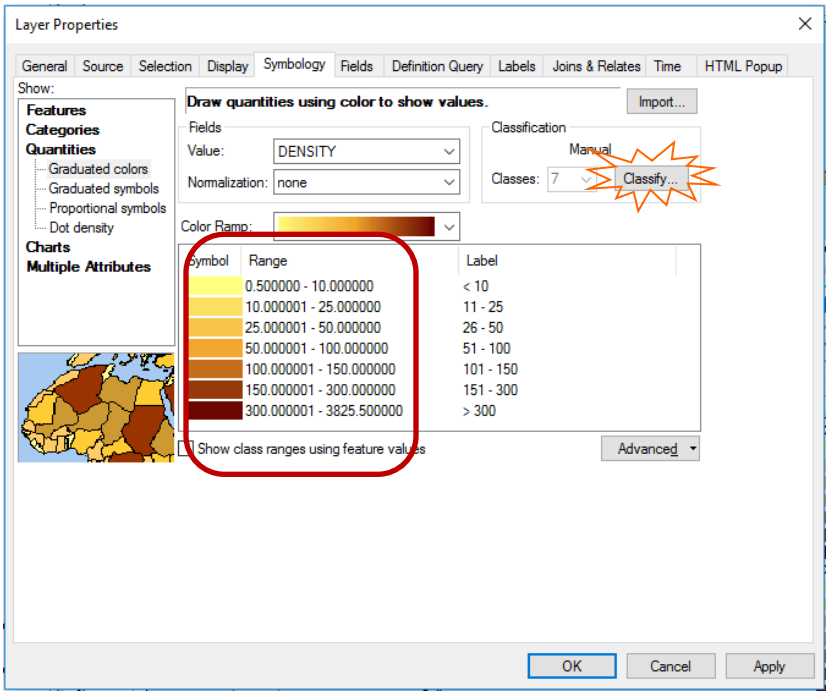
12. Scroll to the top of the Table of contents and right click on Layers tab 

and choose “Paste Layers”. This will copy the same layer that you have already built on population count into the Table of Contents. You will now have two of the same “LLG_pop_2000” layers in your table of contents.

13. Now, double click on the new “LLG_pop_2000” layer that you just copied into your table of contents and Click on the “Graduated Colors” under the Quantities option on the left side of the Layer Properties window (as you did before in step 17 above).

14. Choose DENSITY (this is the population density: average people per square kilometer by LLG).

15. Classify your population density data by clicking on the “Classify” button and choosing classifications for your values. See the picture to the right under the label “Range” which shows how the data classified. (look at step 6 above if you need help). When finished, press Apply and OK.



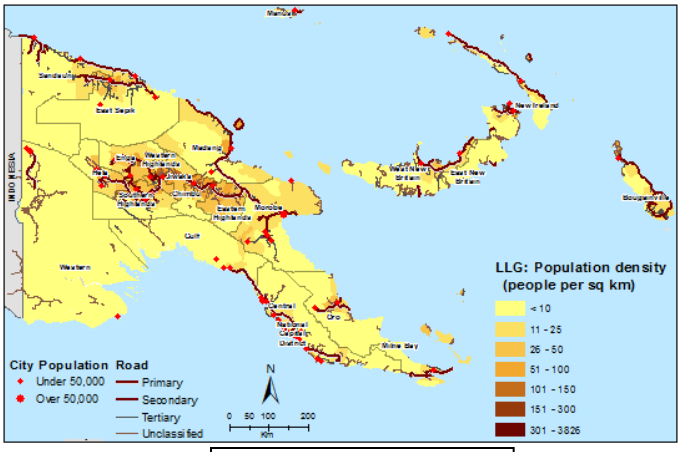
16. Left click on the Symbol tab above the color squares and choose Properties for all Symbols. Under the Outline Color tab, choose No Color for your outline color and then press OK until you exit Layer Properties.

17. Notice how population density changes the further away one gets from the main infrastructure corridors. Turn off and on the “Roads” layer in order to see the Density differences under the “Roads” corridors.

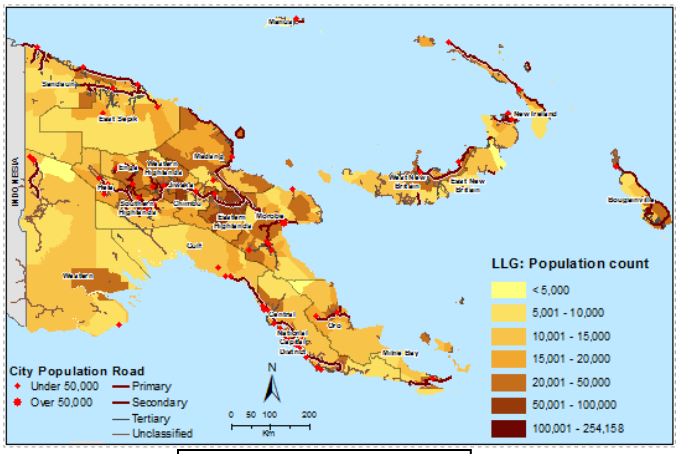
18. Now add your “Provinces” shapefile from your Lab01 folder. Left click on the colored square underneath the layer in the table of contents in order to open the Symbol Selector window. Choose the “Hollow” option and press okay.

19. Turn off the “Roads” layer and just look at the differences between Population Density and Population Count. You can do this by turning off and on the Population Density “LLG” layer. The layer beneath it is the Population Count layer.

20. Looking at the Population Density map, we can see that parts of Hella, Southern Highlands, West Highlands, East Highlands, Egna,and Chimbu provinces have high population density (see two maps below). In these high population density areas, what does the road infrastructure look like? Are they well connected?



Population Density



Population Count

21. Now we will map both of the variables in the same layout window. Switch to the layout view, by clicking on the layout symbol in the bottom left and corner of the map window. 

22. Using the "Insert" menu, add a legend, and other appropriate cartographic elements to your map (North Arrow, and simple scale bar) for the Population Density map.

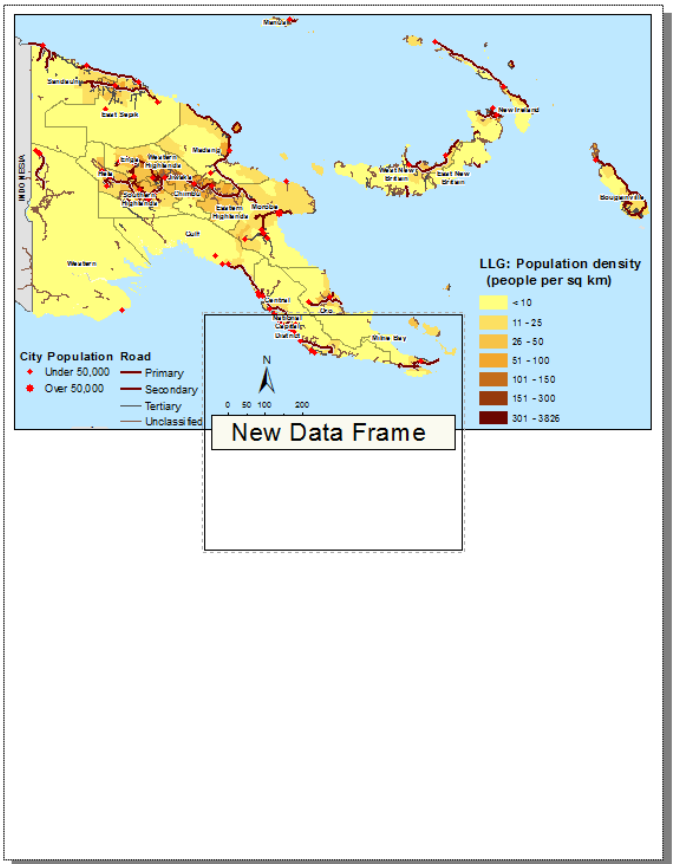
Save your map if you haven't recently!

23. In the layout window, resize the map, so that it is roughly half of the size of the page by clicking once on the map and then dragging one of the corner sizing squares to diminish the size of the map. (You will also have to resize the legend and other elements). Move them to the bottom right hand corner of your layout.

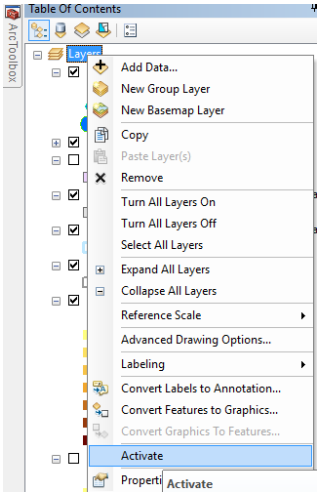
24. From the "Insert" drop down menu, choose the "New Data Frame" option. This will add a new empty map window to your layout. (as seen in the figure-right)

25. Now to add data to your new map window. In the table of contents, right-click on the "LLG_pop_2000" layer in your first Data Frame that you have been working with up until now and scroll to "Copy".

26. Now right-click on the "New Data Frame" listing and scroll to "Paste". Repeat the process to add the "Provinces" layer to your second map window.



27. In a multi-map set-up such as this. Only one map may be considered “Active” at any given time. This means that you can only work on the elements of one map at a time. To “Activate” a map, you can simply click on it in the layout view, or, you can right-click on the title of its corresponding set of layers in the table of contents, and scroll to “Activate”.

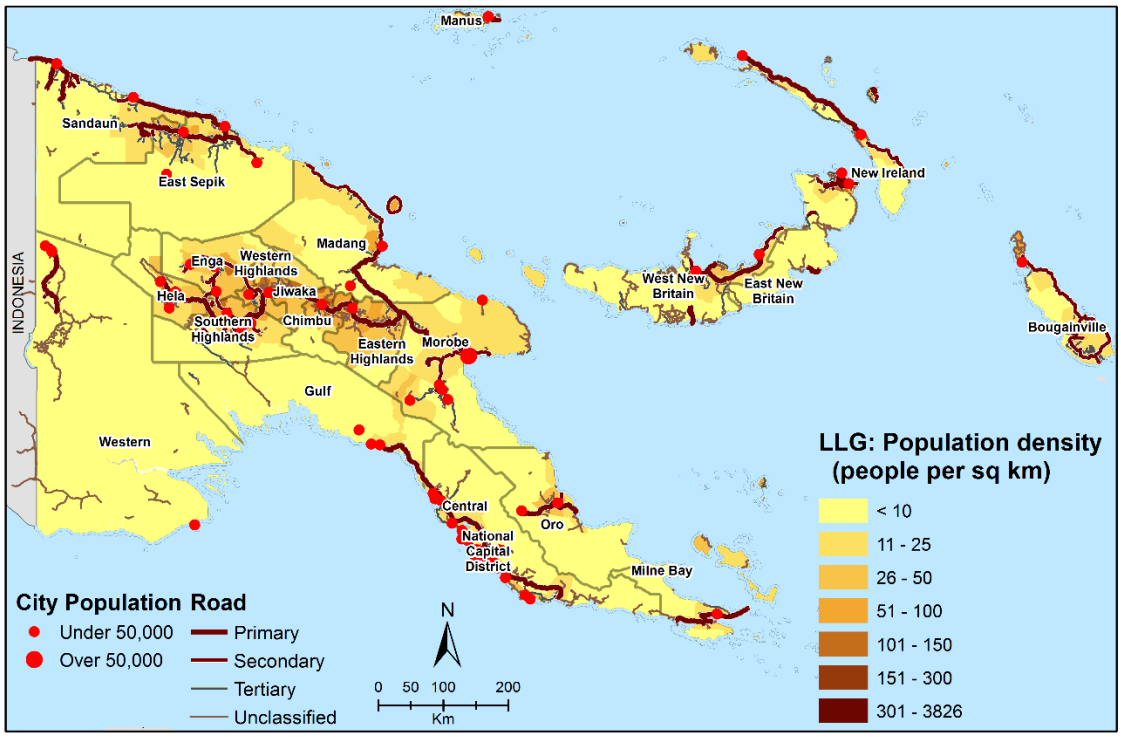


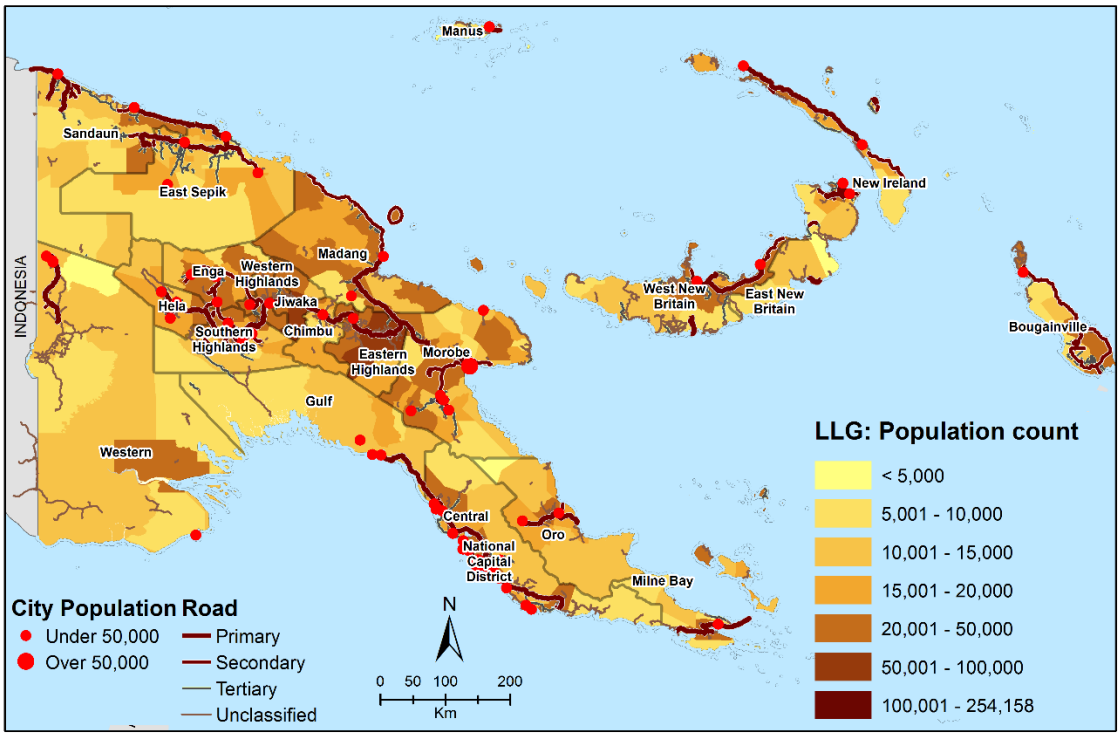
28. On switching to the “Data View” ,  you will notice that only the active map is shown.

29. Test this by switching to the “Data View” and activating (from the table of contents) each map in turn.

30. After understanding varying “Data View” interfaces, put the final touches on the maps (including adding another legend for the Population Count map) that you chose to make and export them as a .jpeg by going to the “File” button in the upper, left corner. Scroll to export and save as .jpeg in your Lab03 folder!

Your layout window should now look something like this, but may have different colors!


Manus
Sandaun
East Sepik
New Ireland
Madang
Enga
Western Highlands
Hela
Jiwaka
Southern Highlands
Chimbu
Eastern Highlands
Morobe
West New Britain
East New Britain
Bougainville
INDONESIA
Gulf
Western
Central
Oro
National Capital District
Milne Bay
LLG: Population density (people per sq km)
< 10
11 - 25
26 - 50
51 - 100
101 - 150
151 - 300
301 - 3826
City Population Road
Under 50,000
Over 50,000
Primary
Secondary
Tertiary
Unclassified
N
0 50 100 200
Km

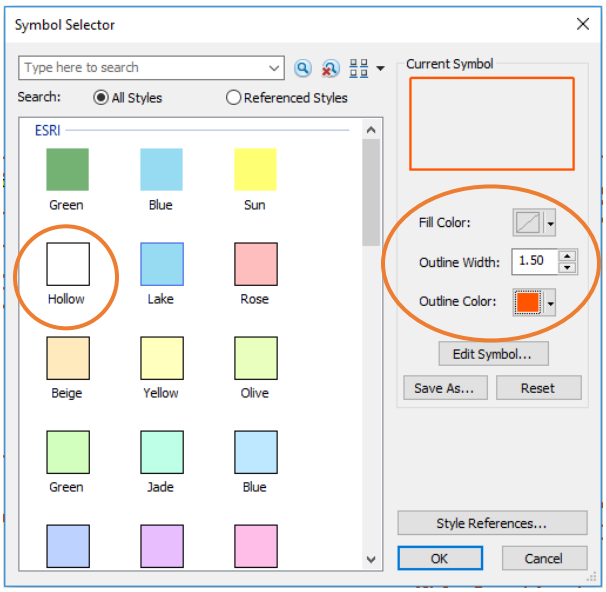

Manus
Sandaun
East Sepik
New Ireland
Madang
Enga
Western Highlands
Hela
Jiwaka
Southern Highlands
Chimbu
Eastern Highlands
Morobe
West New Britain
East New Britain
Bougainville
INDONESIA
Gulf
Western
Central
Oro
National Capital District
Milne Bay
LLG: Population count
< 5,000
5,001 - 10,000
10,001 - 15,000
15,001 - 20,000
20,001 - 50,000
50,001 - 100,000
100,001 - 254,158
City Population Road
Under 50,000
Over 50,000
Primary
Secondary
Tertiary
Unclassified
N
0 50 100 200
Km

Lab 04: Display Surveyed community locations on Google Earth

1. Open a new, blank map by clicking on the “New Map” button  in the upper left corner of your screen below the “File” button.

2. From your Lab01 folder, add the “Districts” shapefile.

3. From your Lab04 folder, add the “Survey_community” shapefile.



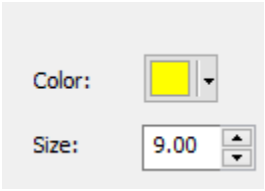
Prepare the layers and maps to be converted to KML by setting certain properties and data attributes that will ensure the KML created matches your requirements and is user-friendly and well-formed.

4. Click on the rectangular symbol beneath

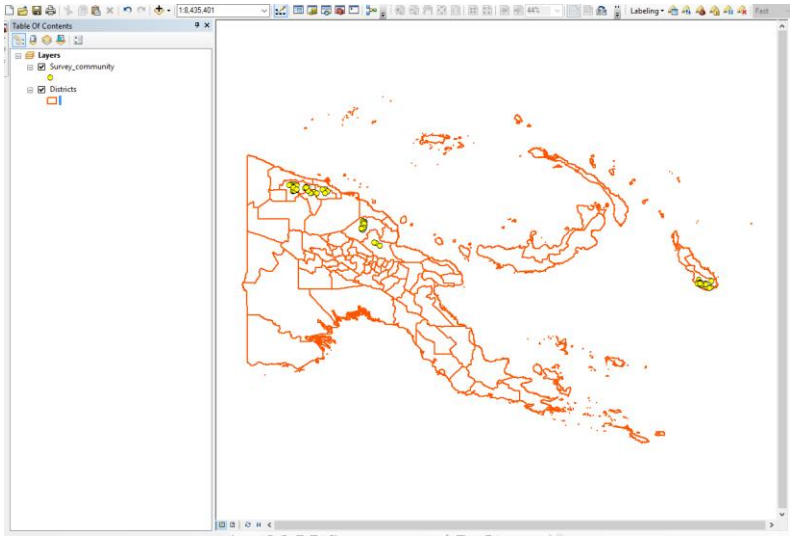
‘Districts’ layer; this will take you directly to the “Symbol selector”.

5. Change Fill Color of ‘Districts’ to *Hollow* and choose an appropriate outline width & color.

6. Change the size and color of ‘Survey_community’ point layer as shown in the picture below



7. Then SAVE your project file as Lab04_YOURNAME to the Lab04 folder.



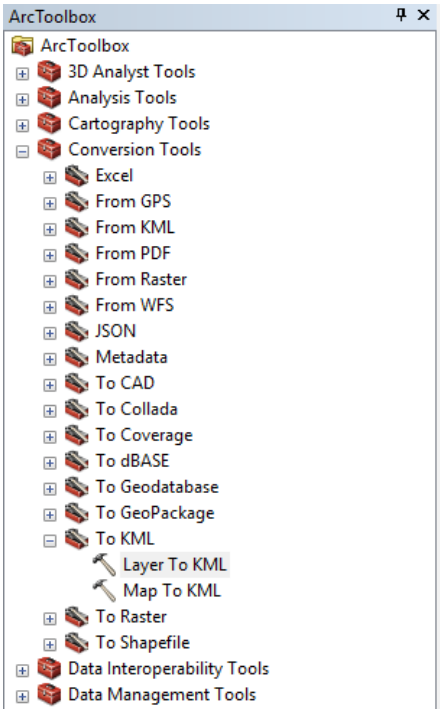
Create the KML file

There are two geoprocessing tools available for creating KML files from ArcGIS data: Layer To KML and Map to KML. Both tools create a KMZ (compressed KML) file in the output location.

- Map To KML will export the entire map into. KML format.
- Layer To KML will export only chosen layers to. KML format

Map To KML

The Map to KML tool allows multiple layers in an ArcMap map document data frame to be simultaneously exported to a KML file. Each layer will be maintained as a distinct folder in the KML, unless the option is used to convert all layers to a single flattened image.

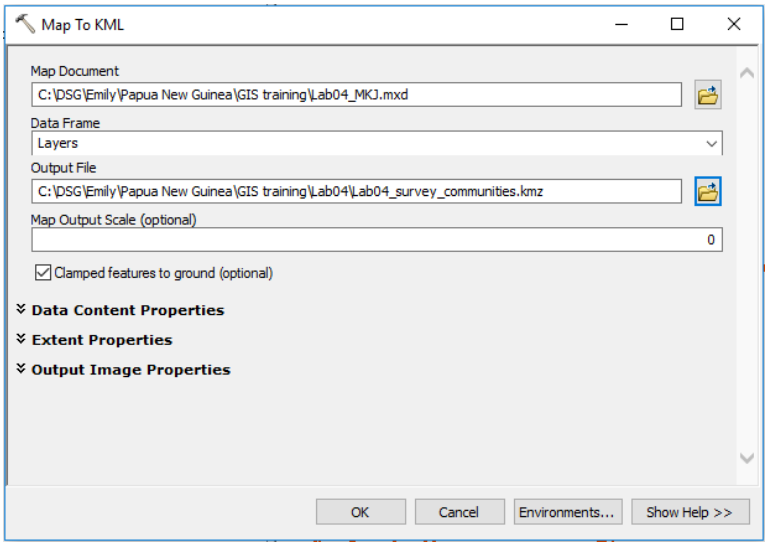


8. Create the KML file using one of the KML conversion tools: Layer To KML or Map to KML , click toolbox  from standard tool bar.

9. In the ArcToolbox window, expand “Conversion Tools,” then “To KML,” and select “Map to KML.”

10. When the “Map to KML” window appears, in the dialog box that appears, fill in the fields:
    - **Map Document:** use the browse button to find ***C:\Student\GISLab\Lab04\Lab04_YOURNAME.mxd***
    - **Data Frame** should automatically set itself to Layers.
    - **Output File**: this is the name and place to which you will save your. KML file. Type in ***C:\Student\GISLab\Lab04\Lab04_survey_communities.kmz***

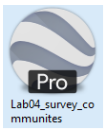
11. Click OK. The Map to KML progress indicator will appear in a new box. When the indicator says Completed, click the Close button.



Open your .KMZ File in Google Earth

12. Open Google Earth.

13. Go to File→Open→ ***C:\Student\GISLab\Lab04***



14. Click and Open ***Lab04_survey_communities.kmz***

15. The map will be overlaid with your file and the globe will spin to PNG. Zoom in using the Zoom slider to magnify the map to the desired scale to see the individual/cluster of surveyed community locations. You can click on a community point to activate a popup box that will display the attribute information.

Layer To KML
The Layer To KML tool allows individual layers to be exported directly from ArcMap. You can control the appearance of KML in the properties of the layer being converted.

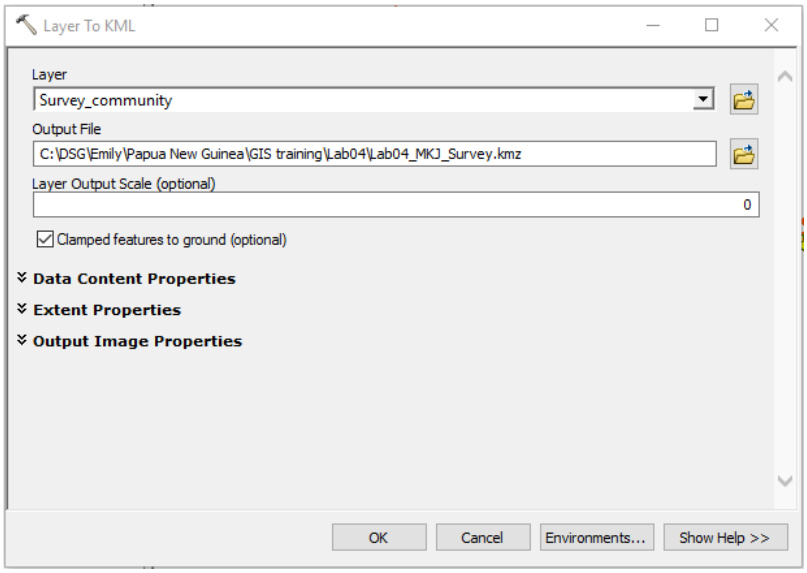
1. If it is not open, first, open the .mxd file saved in Lab04 named after your name

2. In the ArcToolbox window, expand “Conversion Tools,” then “To KML,” and select “Layer to KML.”

3. When the “Layer to KML” window appears, first select the shapefile ‘Survey_community’ layer for the “Layer” box.

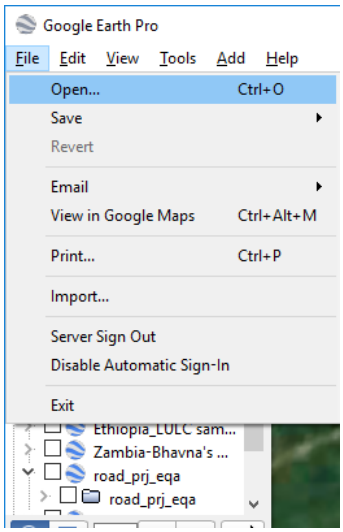
4. Next select a directory (Lab04) for the file to be created and provide a name as “Lab04_YOURNAME_Survey” for the file.

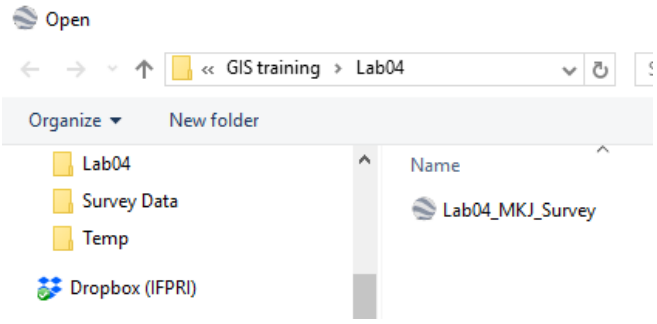
5. Click OK.



6. Now, open Google Earth and from main menu click File>> Open….

7. Locate the KMZ file saved in Lab04 as “Lab04_YOURNAME_Survey.kmz”





8. Since you have only converted the survey community locations, what displayed in the google earth is surveyed community locations. You can convert district layer and add to google earth.


Bismarck Sea
Papua New Guinea
Daru Island
Port Moresby
Dyke Ackland Bay
Image Landsat / Copernicus
US Dept of State Geographer
© 2018 Google
160 km
Google Earth

Lab 05: Understanding Projections

Projecting Map Data using ArcMap

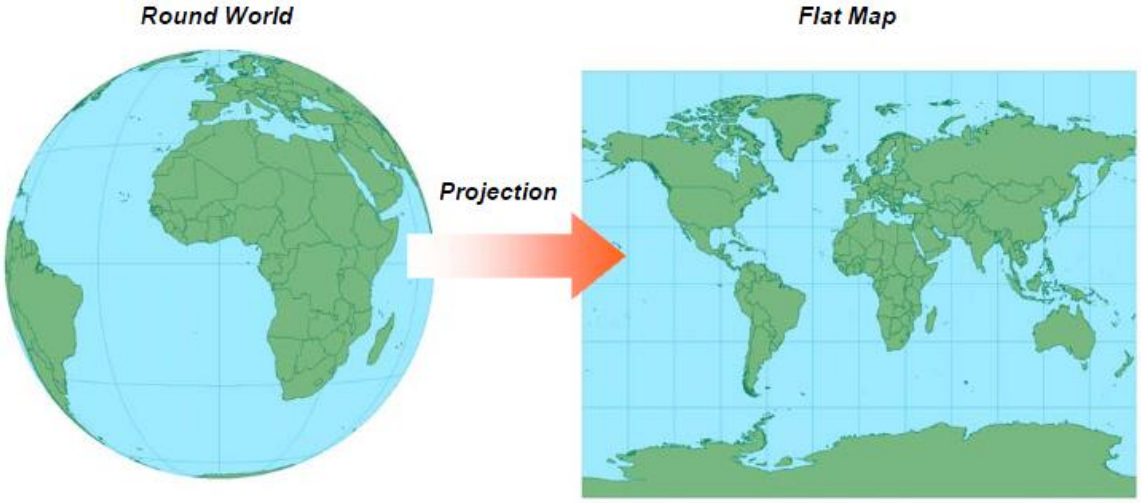
The location of any given place can be defined with reference to lines of latitude and longitude, which create an imaginary mesh over the world. Latitude and Longitude values belong to a spherical coordinate system – a system for defining locations and making measurements on a sphere, or something close to a sphere (a spheroid) like the earth.

The latitude - longitude value of a point depends on the assumptions you make about the earth's shape. The earth isn't perfectly round. It bulges at the equator and is flattened at the poles. Technically, this makes it an oblate spheroid.

Besides not being quite round to begin with, the surface of the earth has various bumps and indentations. Determining the exact shape of the earth is not a simple matter.

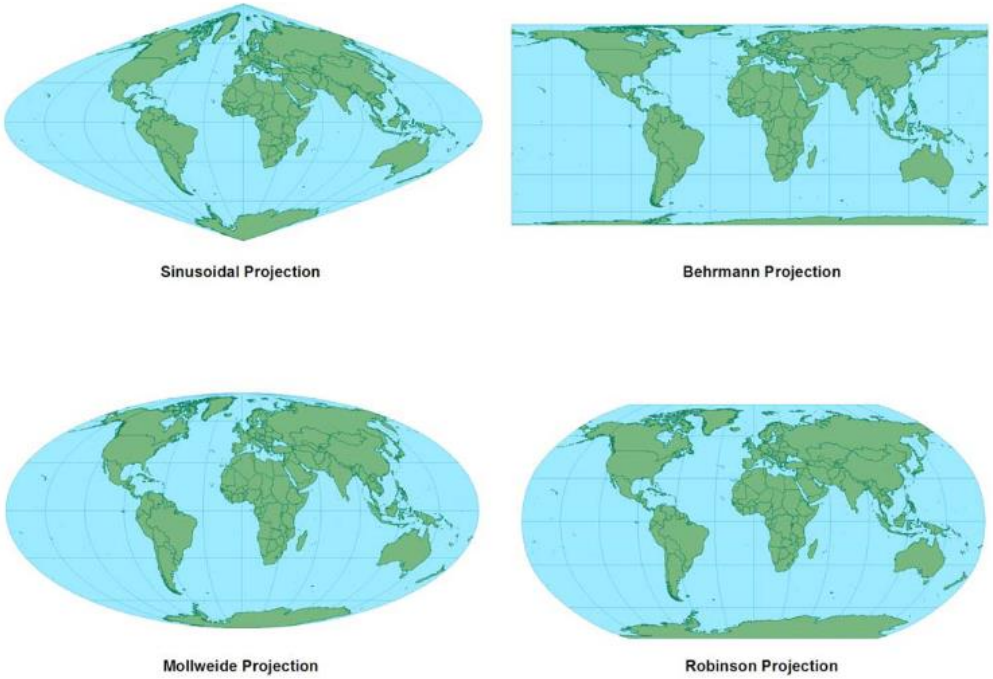
There are many different models and ArcMap recognizes almost three hundred different projections.

To make one map, one of these models of the earth (or some part of it must be represented on a flat surface. This is accomplished by a mathematical transformation called a ***map projection***.



Just as location on a sphere is defined by latitude and longitude, location on a map is defined by *Cartesian* coordinates, which assign values to points according to their positions on a horizontal x-axis and a vertical y-axis. As opposed to a spherical coordinate system, this is known as a planar coordinate system.

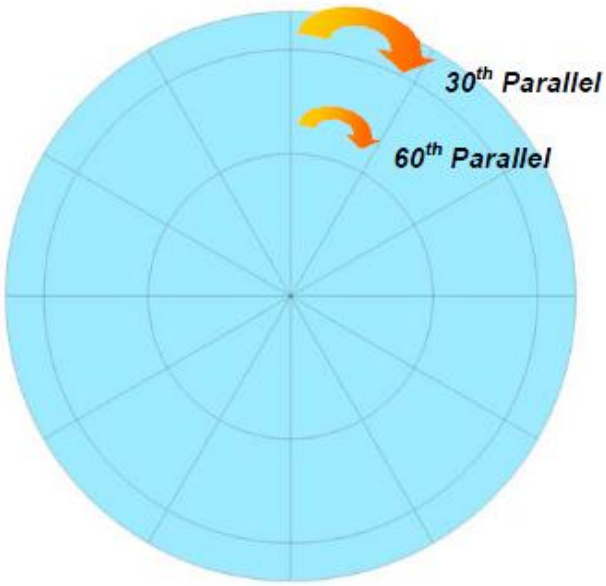
The exact location of a point on a map varies according to the map projection used. There are about 50 commonly used projections and many variations on each.



Four world projections. Many projections are made for individual continents, countries, parts of countries, or strips of land that may cross international boundaries.

Every spatial data set in a GIS stores geographic coordinates for its features. These coordinates make up its *geographic coordinate system* (GCS). A data set that has been projected also stores *Cartesian* coordinates for its features. These make up its *projected coordinate* system.

When you work with unprojected data (data that has only a geographic coordinate system), any measurements or calculations you make are only based on a sphere or spheroid. This is problematic because degrees of latitude do not have constant length. A degree of latitude at the 30th parallel (30 degrees north of the equator) is longer than a degree of latitude at the 60th parallel. Both represent 1/360th of a circle, but the circles have different circumferences.



View from the North Pole

Since degrees of latitude are not constant, they can't be used to make meaningful measurements of distance and area. This problem is overcome with map projections. On a flat surface, units of measurement (meters or feet, for example) are constant, which means that you can calculate meaningful area and distance measurements. There is another difficulty however. Since the world is a sphere, and maps are flat, you can't go from one to the other without changing the proportions of features on the surface. Map projections distort shape, area, distance and direction. Some projections preserve one of these properties at the expense of others, some compromise on all of them, and some preserve properties for one part of the world and not the others. The Mercator projection, for example, preserves direction, but distorts area. The sinusoidal projection preserves area but distorts shape.

Mercator Projection

Sinusoidal Projection

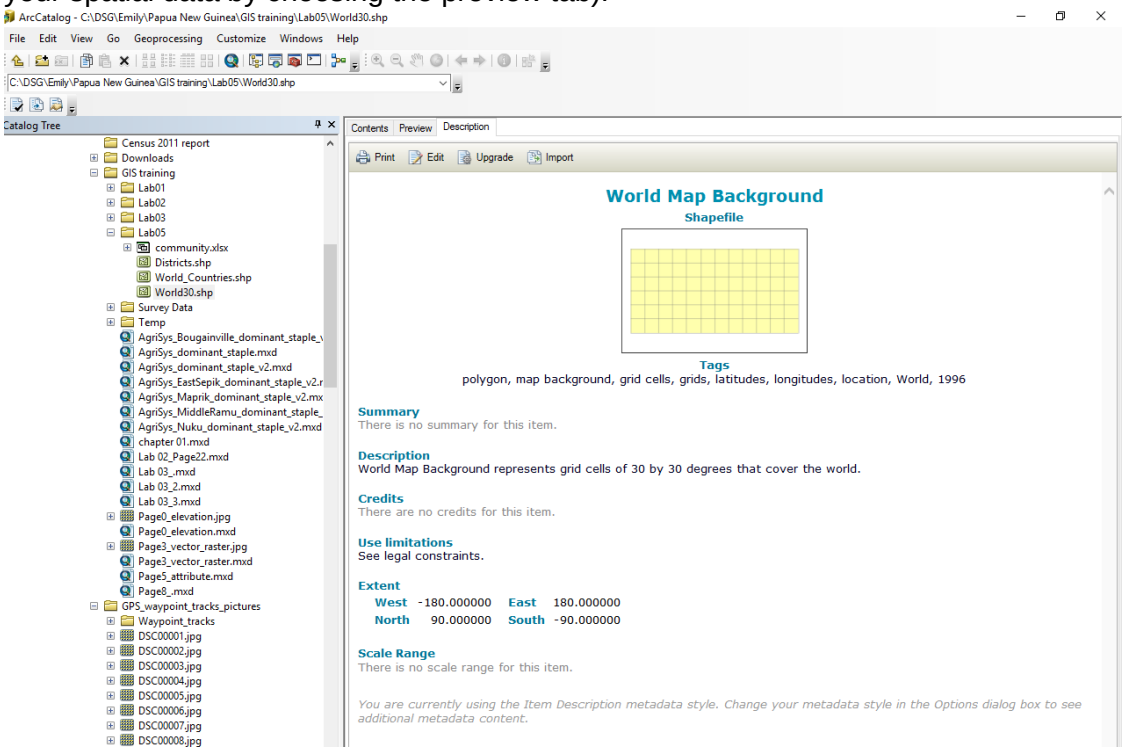
In the Mercator projection, Greenland looks larger than Brazil, although Brazil is four times its size. Because direction is preserved, Brazil correctly appears due south of Greenland. In the sinusoidal projection, the proportional sizes of Greenland and Brazil are correct. Their shapes however are distorted – Greenland is too narrow, and Brazil is too wide.

Your choice of map projection allows you to control the type of distortion in a map for your area of interest. If you are working with a fairly small area and using an appropriate projection, the effects of distortion are insignificant. If you are working with the whole world, there is bound to be significant distortion of some spatial property.

When you add a layer to a map, both its appearance, and, the results of measurements and calculations you make depend on its coordinate system. You can find a data set's coordinate system in its spatial metadata.

To access the metadata for your file (if indeed it exists) open ArcCatalog. ArcCatalog is a standalone application for managing geographic data. It is part of the ArcMap Suite, and is essentially an interactive browser for spatial information.

To view the metadata for a particular file, double-click on the ArcCatalog icon on your desktop. In the table of contents, navigate to your chosen file. Highlight this file, and click on the Metadata tab that sits over the view window. (You can also access a preview of your spatial data by choosing the preview tab).



When data sets that have the same coordinate system are added to a data frame, the features in each layer are correctly positioned with respect to each other. If you subsequently add a data set that has a different coordinate system, ArcMap changes it to match the others in a process called "on-the-fly" projection. This new, temporary projection is applied only within a particular data frame; the data set's native coordinate system (the one shown in its spatial metadata) does not change.

By default, layers are projected on the fly to the coordinate system of the first layer added to a data frame (even if the layer is later removed). The coordinate system is

stored as a property of the data frame and can be changed. You can project all layers in a data frame to any coordinate system ArcMap supports.

To project a layer on the fly, ArcMap uses the information stored in its geographic coordinate system. On-the-fly projection works best when all layers in the map have the same GCS (in other words, when they all use the same model of the earth.)

On-the-fly projections are less mathematically rigorous than permanent projections (which change the native coordinate system of the data set). If you plan to use data sets in an exacting analysis, you should project them permanently to the same coordinate system with the *ArcToolbox Projection Wizard.*

Go to the next page for the Lab05 exercise.

Lab 05 - Part 1: Changing Data Projections in ArcMap

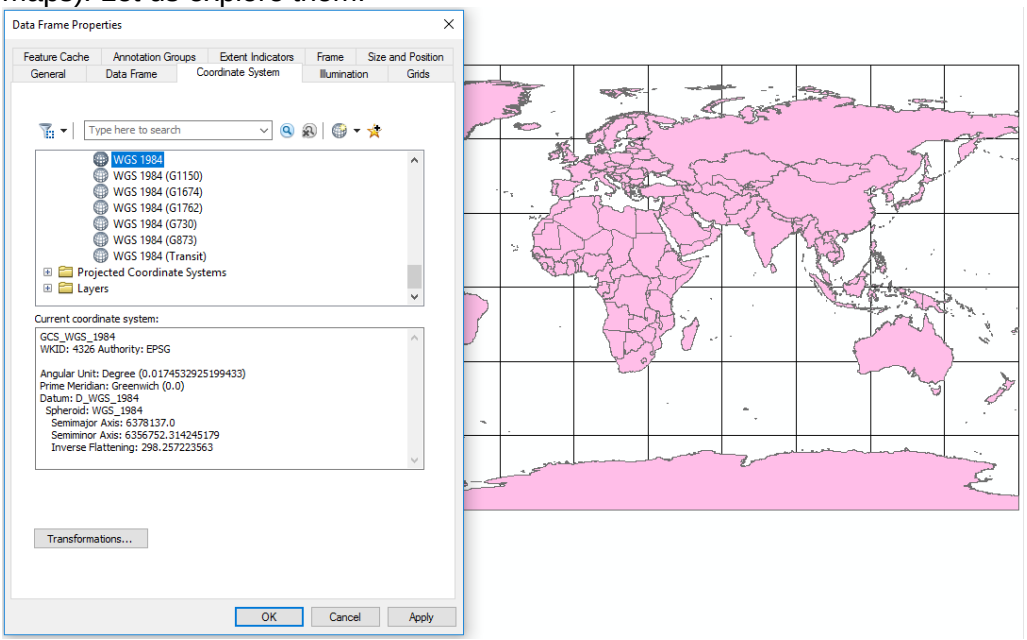
1. Open ArcMap, and from your Lab05 folder, open the files, “World_Countries”, and “World30”. Change the Symbology of the “World30” layer so that it is a hollow fill, with black or grey outlines.

2. Right click on “Layers” in the table of contents and point to “Properties”. Select the tab “Coordinate Systems” (if not already selected by default).

3. Move the Properties window a little to the right so that the majority of your map is visible.

4. You will see, under the box “Current coordinate system” that these shapefiles presently have a geographic coordinate system called “GCS_WGS_1984”. This stands for “Geographic Coordinate System (GCS), World Geodetic Survey (WGS), 1984”

This is a popular projection for the World, and is the reference system used by GPS (Global Positioning System) Units. However, there are alternate projections available (such as those introduced in the intro, and they have different purposes for different maps). Let us explore them.



5. In the folder tree, click on the folder (folders where all the alternate projections are stored). In the next list of folders, click on “Projected Coordinate systems”. The subsequent list is quite long, scroll to the end and click on “World”.
These are the world level projections available in ArcMap.

6. Select “Cylindrical Equal Area”, then click Apply, and OK. The appearance of your world map should change dramatically. (You may get a pop-up box asking you if you are sure that you want to do this, Just click OK).

7. Move to the “Layout View” for your map. Resize your map so that it fits the whole page.

8. Return to “Layer Properties”, and click on the tab “Frame”. Remove the “Border” from around your map window. Then click OK. (This will make your final product a little less cluttered, as we plan to use several images).

9. At this point, save your map in your Lab05 folder as “Lab_05World.mxd”.

10. Next, go to the “File” dropdown menu. Choose “Export map”, and save your map, (as a .jpeg with resolution of 150), in your Lab05 folder as “C Equal Area”.

11. Return to the table of contents. Once again, right-click on “Layers” and scroll to “Layer Properties”. Select the tab “Coordinate System” and following the same route as Step 5; (Projected…./World), select the projection “Equidistant Conic”. Click Apply, and OK.

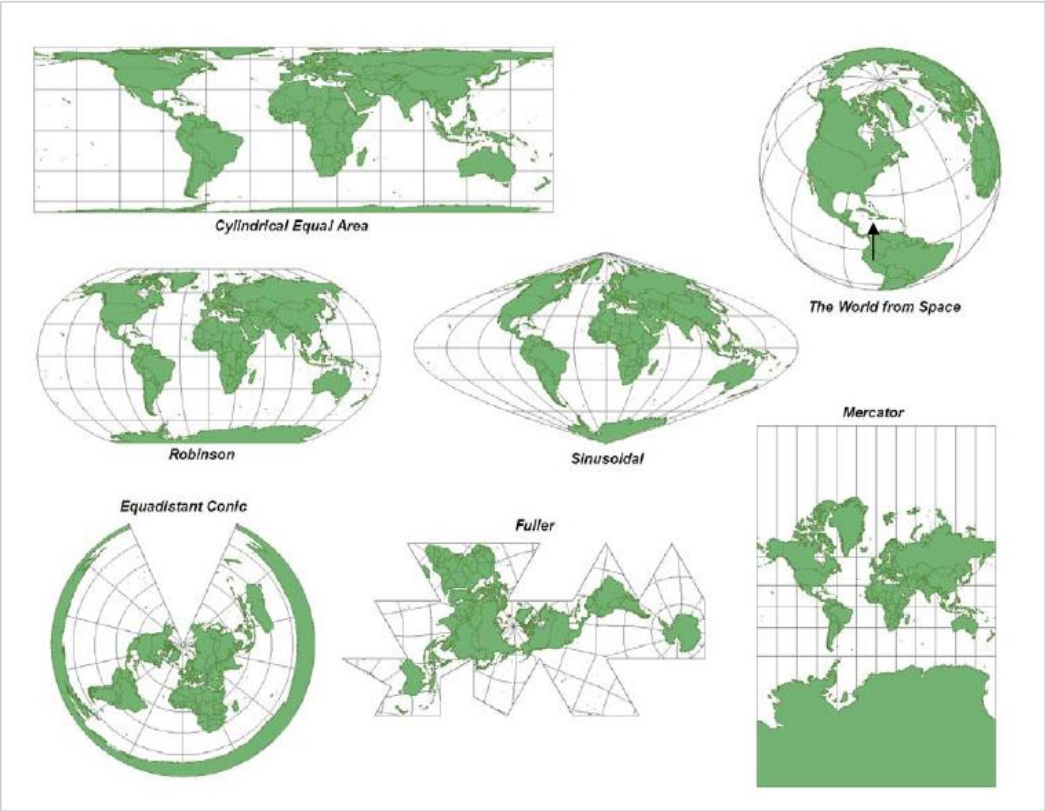
12. Look at how different this view of the world is! Once again, export this map as a .jpeg with resolution of 150dpi. Choose an appropriate name, e.g. “Equid Conic”.

13. Using the instructions from the previous steps, produce 5 additional jpegs of the world using the following projections:

a. Mercator
b. Sinusoidal
c. The World from Space
d. Fuller
e. Robinson

14. Using Microsoft word, or PowerPoint, inserts the jpegs onto one page/slide. Label each projection according. See the next page for a sample layout of all images.

15. Your finished product should look somewhat like the following graphic on the following page:



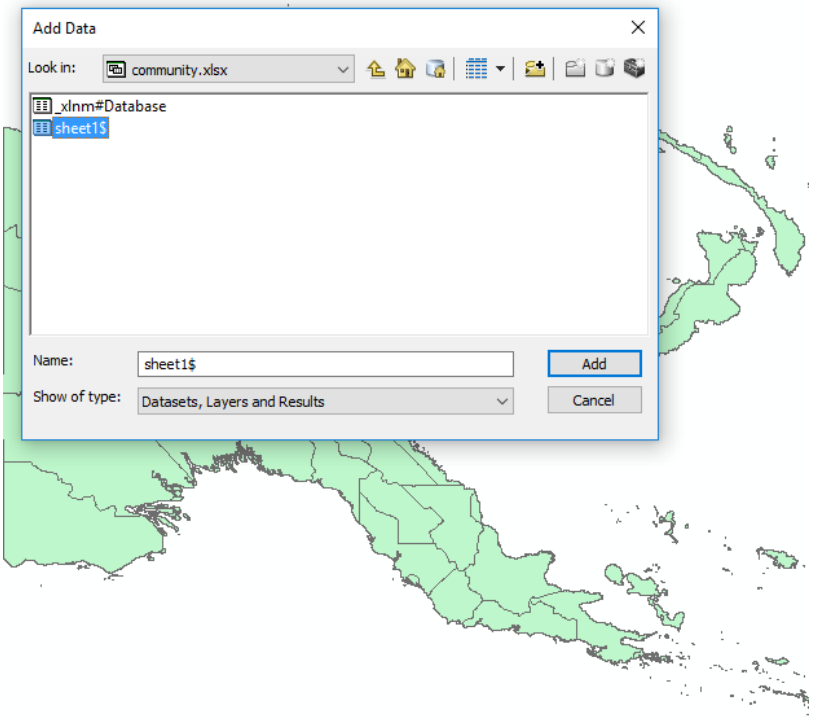
Lab 05 part 2: Bringing Field Data into the ArcGIS software program. Allowing visualization using GPS point data.

Assume a survey team has just returned from mission and gave you a simple database file containing the X, Y (latitudinal & longitudinal) information of survey community centers in certain districts of PNG. This information must be visualized, and integrated into the spatial data repository.

Close ArcGIS before you begin this exercise.

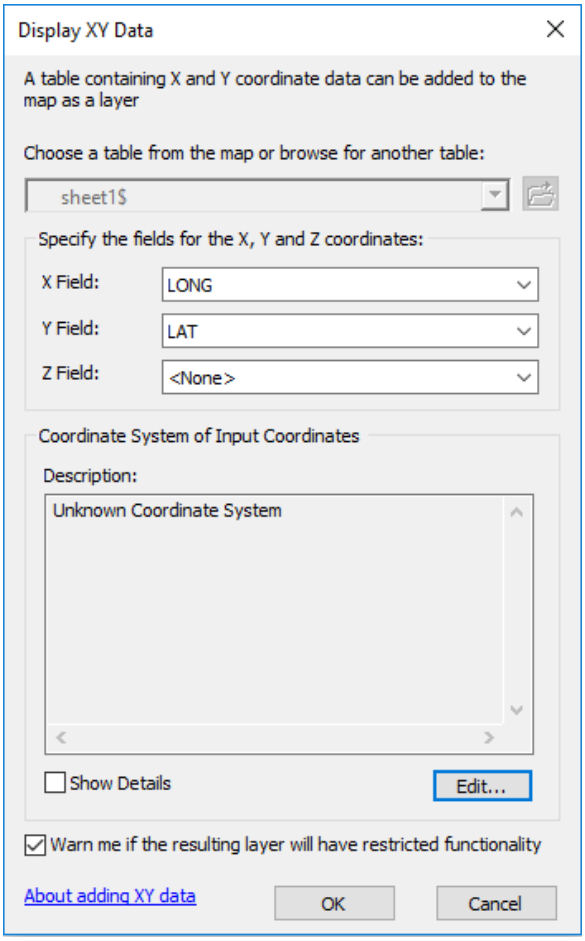
1. Open Excel and go to your Lab 05 folder. Open “community.xlsx”. You can see that there is a “LONG” (longitude) and “LAT” (latitude) field, along with other information that describes community location.

2. You can directly bring an Excel worksheet into ArcGIS. Add the file “Districts” and the database file: “community.xlsx” and choose ‘sheet1$’ from the from your Lab05 folder.



3. Right click on the ‘sheet1$’ file and scroll to “Display XY data”. Click on “Display XY data” and a window should pop up like the window to the right.

4. Make sure that your “X Field” displays LONG for the coordinates, and your “Y Field” displays LAT for your coordinates. Press OK



5. You may get a warning message stating that your “Table Does Not Have Object-ID Field”. This is a unique identifier that ArcGIS builds into all of its shapefiles. Press OK and ArcGIS will create this field for you.

6. Now, can you see your “sheet1$ Events” points? **Where are they?** Right click on the “sheet1$ Events” layer, and from the menu choose “Zoom to layer”. The “sheet1$ Events” layer should now be visible, but not the “Districts” layer.

7. Right click on the “Districts” layer and choose “Zoom to Layer”. What happens to the “sheet1$ Events” layer? Magic, it disappeared…**or is it a projection problem**??
8. Go to the main tool bar, and select the “Zoom to full Extent” button 

9. You should now see the entire “Districts” layer, with one tiny dot to the South of the country. If you use the regular zoom tool  , and zoom repeatedly into this dot or draw a small square with your zoom tool, you will realize that it is in fact the “Community” layer. As it is in a

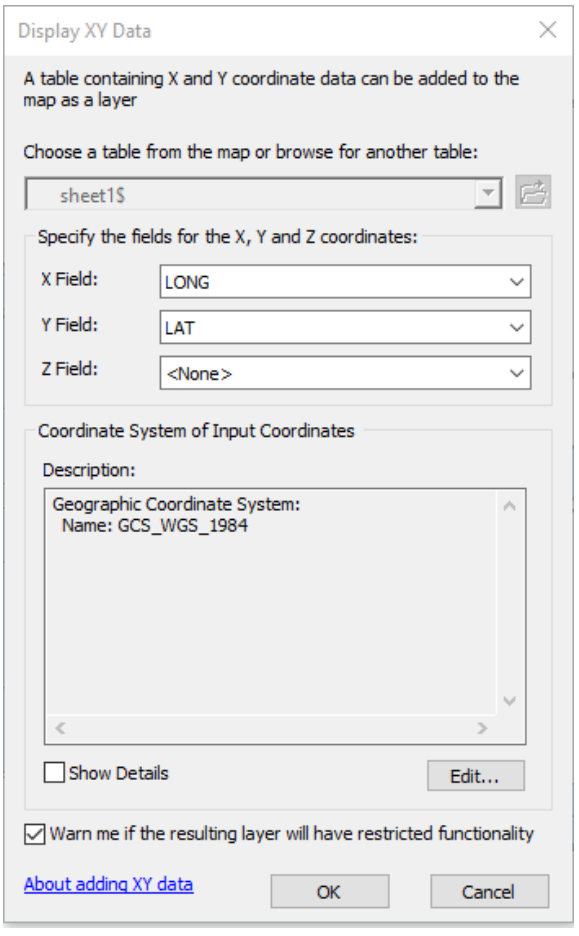
different projection, it is unable to locate and resize itself correctly in relation to the “Districts” Layer.

10. If we take the assumption that this information was collected by GPS, then reverting to the default coordinate system used by GPS will correct this issue.

11. So let’s try our hypothesis! First, Right click on the “sheet1$ Events” you select Remove.

12. Now, right click on the “healthcenters.csv” layer. Left click on the “Display XY Data”.

13. As you can see, the coordinate system is unknown. Click on the “Edit” button. In the next window, click the “Select” button and choose the following path:
    Geographic Coordinate Systems
        World
            WGS 1984



14. Click Add.

15. Your “Add XY Data” window should now look like the graphic to the right. Click OK

16. Now your community should be geographically contiguous with your “Districts” layer.

17. Your “sheet1$ Events” is currently only a cosmetic layer. We know this because it has the word “Events” following the name. It is not yet a shapefile.

18. To create a permanent shapefile from this cosmetic layer, right click on the “sheet1$ Events”, scroll down to “Data” and select the “Export Data” option.

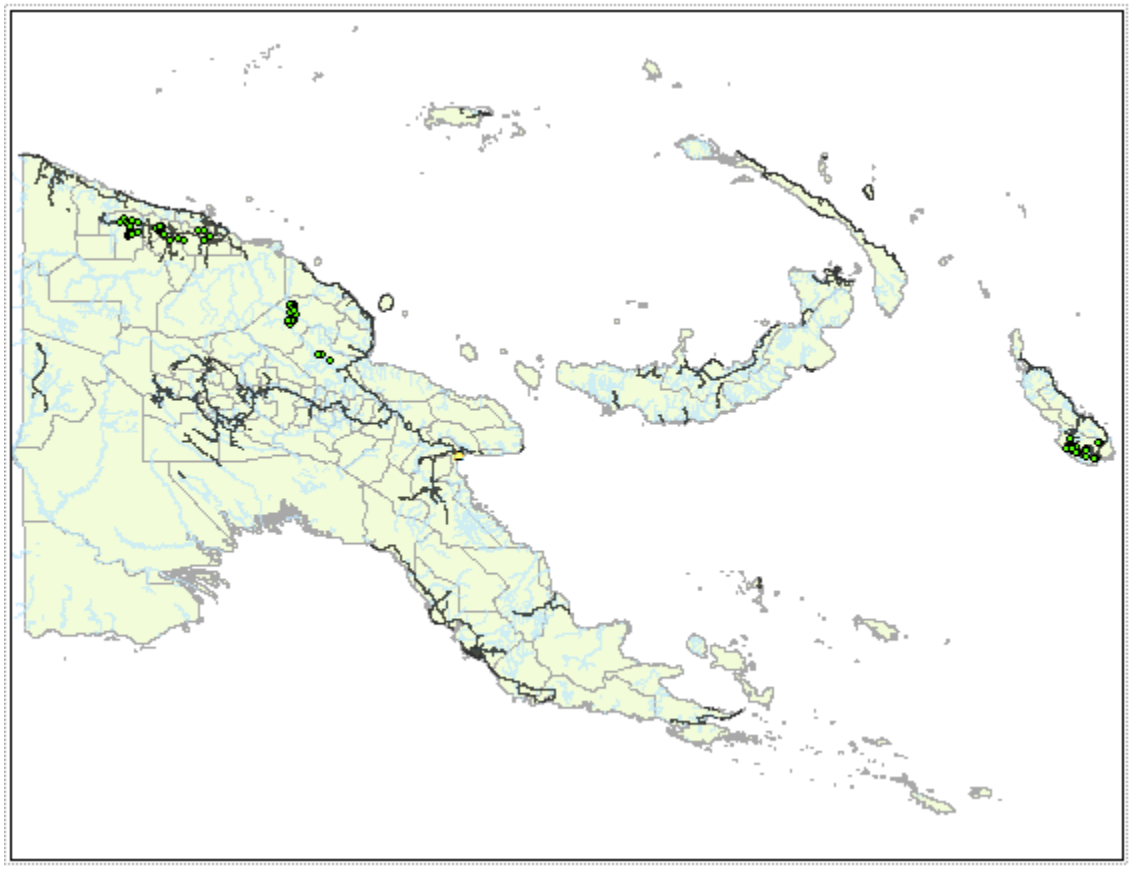
19. Leave all the initial options as default, but make sure to save the final file to Lab05 folder, calling the file “Community.shp”

20. A pop – up window will ask you if you would like to “Add to map”. Select OK and the new shapefile should automatically add to the dataframe.

21. Look at these data, where are community missing, why? Add some other geographic data from your Lab01 – Lab04 folder (including roads) to see if you

can hypothesize. Just looking at your map, can you tell the pattern of the community surveyed?

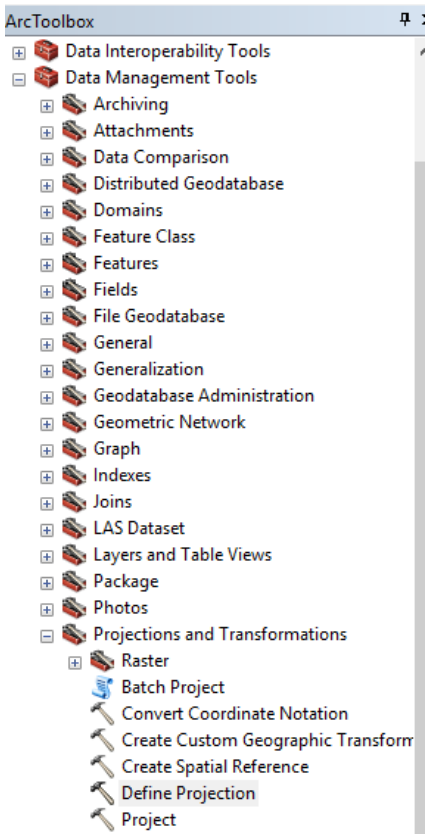
22. Create a map with the community layer, and other key data. (hint: are they located along the road or river?)



Lab 06: *Exporting external database information from ArcMap*

Exercise Overview

*Now you will perform what is known as a **Spatial Join**, links/combines the attributes of two layers, based on the location of each layer's features. Just like a table join, a spatial join appends the attributes of one layer to another. You can then use the additional information to query your data in new ways.*



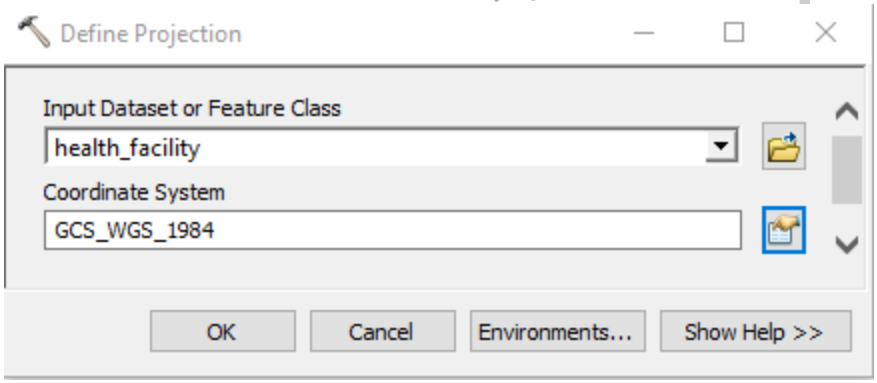
1. Open a new ArcMap session and add your new "health_facility" layer that you created in the previous exercise.

2. Before you begin this exercise, you may need to add the spatial toolboxes to your data screen. If the list of toolboxes (see left) is not on your screen click on the  button from the standard toolbar.

3. Now, let's make sure that your "health_facility" layer has a defined projection by going to the toolbox "Define projection" (see graphic Right).

4. Define the projection in the "Select a Coordinate System" box, choose the following path:
   Predefined
   Geographic Coordinate Systems
   World
   WGS 1984

5. Press OK. Now that we have defined all of our projections we can do a Spatial Join!



6. Add your "Provinces" and "Districts" layer from your Lab01 folder.

7. Right click on the "Districts" layer. Go to "Joins and Relates" > "Join"

8. In the first drop down menu (see right), change the option to "Join data from another layer based on spatial location". This choice will change the look of the wizard layout.

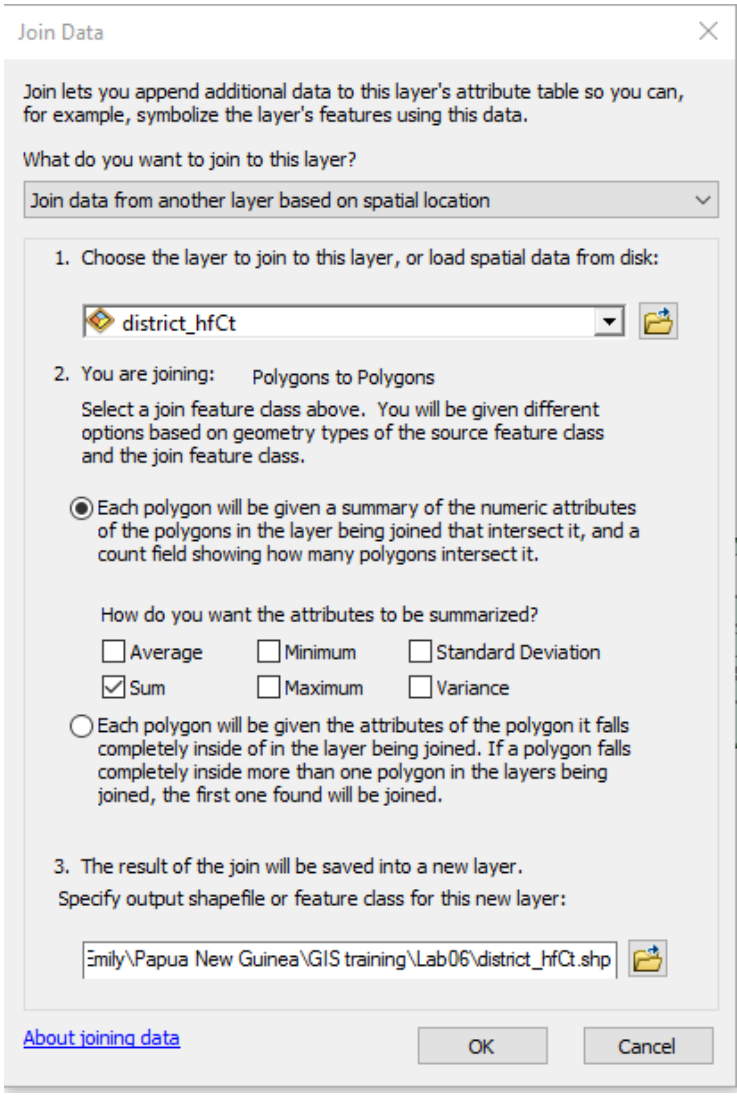
9. Use the graphic to the right to select the correct options.

10. For Option 2: make sure the first radio button is selected (it should be by default), and that the “Sum” check box is ticked.

11. Save the new file to your Lab06 folder, and call it “district_hfCt”.

12. Click OK.

13. The join process may takes few seconds, as ArcMap must count the number of health centers located in each district, and report that data in the attribute table of your new file “district_hfCt”

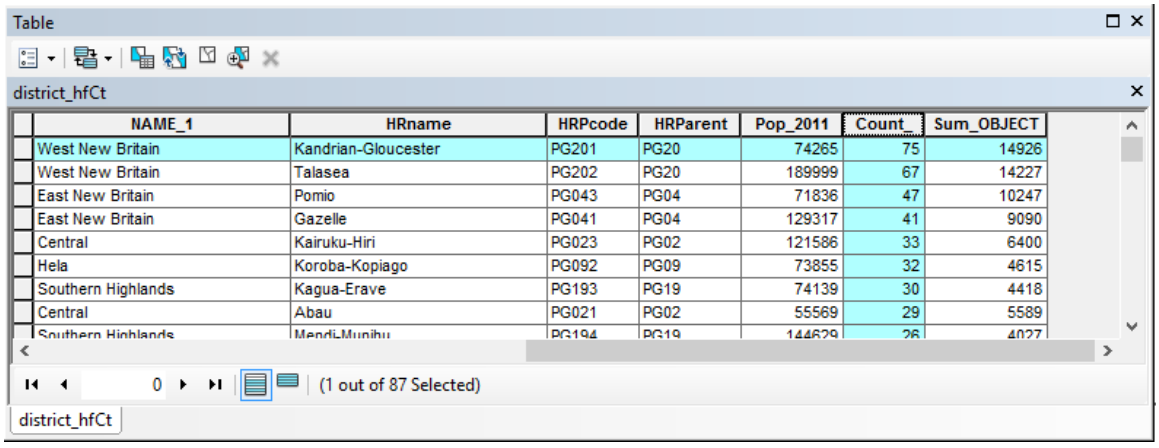


As you can see, there are many other options within the Spatial Join tool. It can be used to determine how close an individual point or polygon is to another point or polygon in a different layer, and report its distance. You will use this function in a later exercise.

14. “district_hfCt” should automatically add to your table of contents, if not, go to the “Add data” button, and from your Lab06 folder, add the new “district_hfCt” layer. For clear visibility, re-organize the layers.

15. Open the attribute table of “district_hfCt” and scroll right until you see “Count_”.

16. The field that you are interested in is the “Count_” field. Right-click on the field heading, and choose the “Sort by Descending” option. You will see that the maximum number of health centers for any one district is 75.



NAME_1	HRname	HRPcode	HRParent	Pop_2011	Count_	Sum_OBJECT
West New Britain	Kandrian-Gloucester	PG201	PG20	74265	75	14926
West New Britain	Talasea	PG202	PG20	189999	67	14227
East New Britain	Pomio	PG043	PG04	71836	47	10247
East New Britain	Gazelle	PG041	PG04	129317	41	9090
Central	Kairuku-Hiri	PG023	PG02	121586	33	6400
Hela	Koroba-Kopiago	PG092	PG09	73855	32	4615
Southern Highlands	Kagua-Erave	PG193	PG19	74139	30	4418
Central	Abau	PG021	PG02	55569	29	5589
Southern Highlands	Mendi-Munihu	PG194	PG19	144629	26	4027

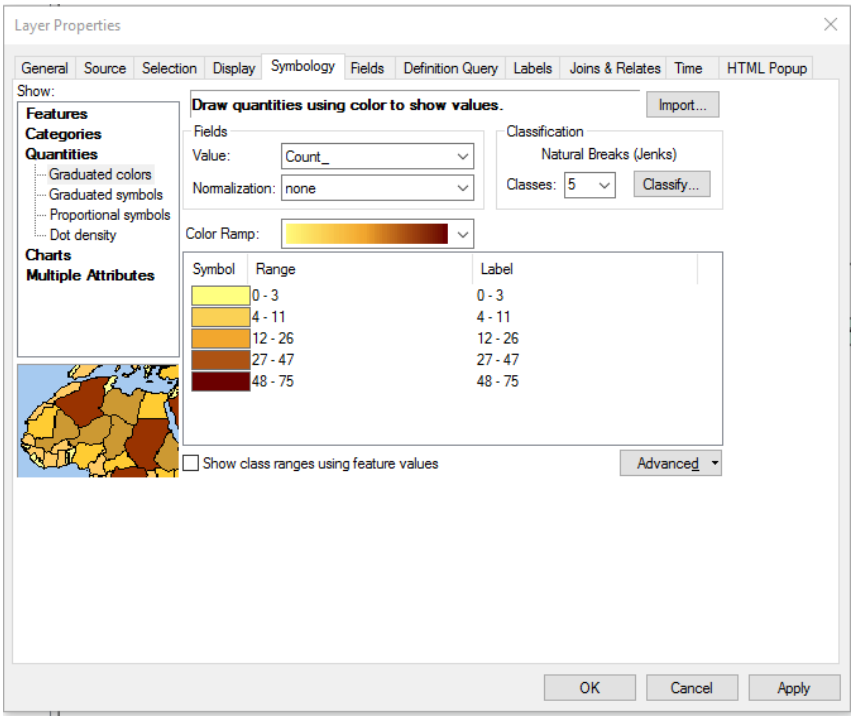
17. Close the Attribute table for now, and let’s create a thematic map.

18. Double click on the “district_hfCt” layer. This will take you to the “Layer Properties” dialog. Click on the “Symbology” tab. In the “Show” menu to the left, Click on Quantities > Graduated colors.

19. In the “Value field”, click the down arrow and scroll to “Count_”.

20. In the “Color Ramp” field click on the down arrow and choose a color scheme that you like.

21. Click OK when complete.



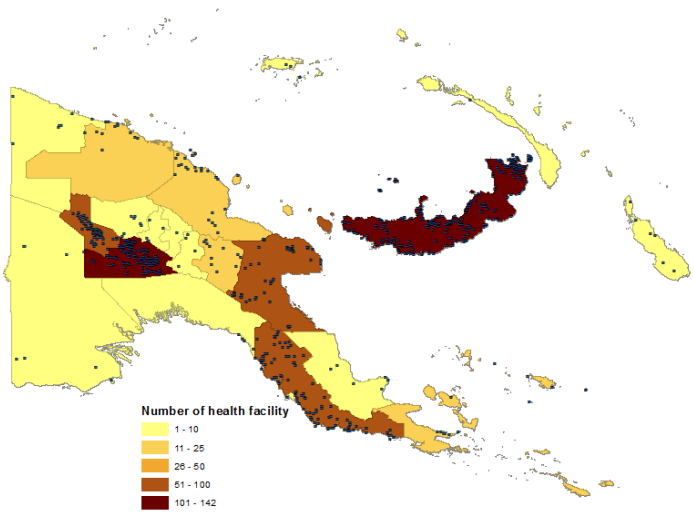
22. Before you progress too far in your map production, let’s once again save your map as an ArcMap Document file (. mxd) so you won’t lose your work to date. Go to “File/Save As”, navigate to your “Lab06” folder, and name the Project file: “Lab06_YOURNAME”.

23. Now make sure that your “health_facility” shapefile is above your “district_hfCt” file in the table of contents so you are able to see both layers.

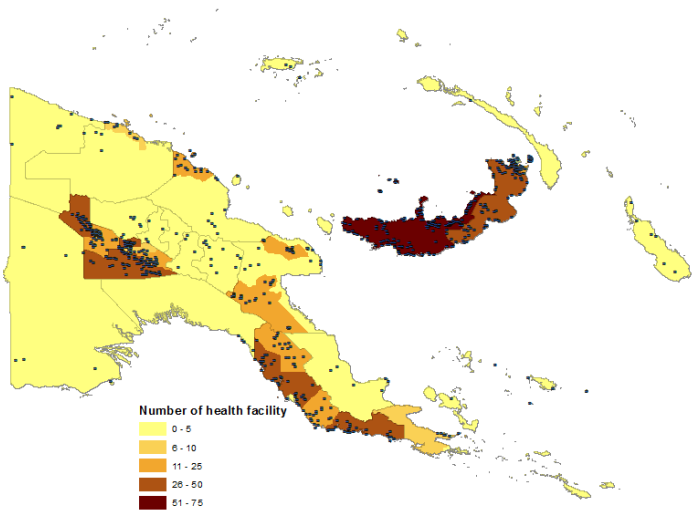
24. Given that the districts are geographically larger than LLG, would it be better to look at statistics on a more disaggregated level. You can do the same spatial join on your LLG layer to understand health facility placement at a finer level.

Think about how you would aggregate similar data such as road data – you could do a spatial join, and average road lengths by district in order to arrive at a road density figure.

Here is the difference between the province and district level statistics!



Province Level



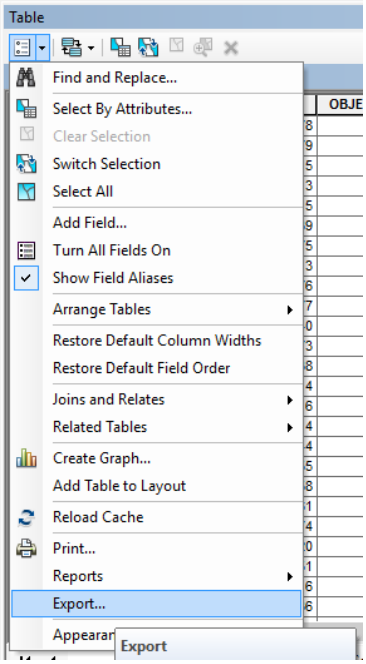
District Level

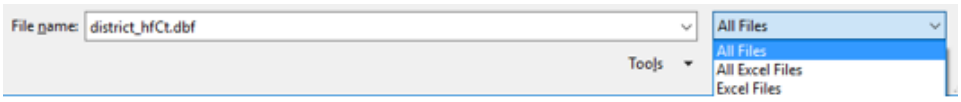
25. Now you will export this data to excel for graphing purposes.

26. Open the “district_hfCt” attribute table again. On the top left hand corner of the attribute table, click on the “Table options” button. From the menu, choose the “Export” option.
27. Export your table as “district_hfCt” to your Lab06 folder. Although the file carries a .dbf extension, you will be able to open it in Excel, and save it to as regular ‘‘.xlsx” file from which you will create your graphs.

28. Go to Microsoft Excel, and from your Lab06 folder open the “district_hfCt.dbf” file. Note, you have to change the “Files of Type” dropdown to “All Files” in order to see those files with a .dbf extension (see below).

29. Now you can save your table as an “.xlsx” file (excel) and graph it if you would like.





Lab 07 – Data Integration and Thematic Mapping

Exercise Overview
You have received detailed Household Census information from the NSO of PNG. The data is in Microsoft Excel format, and you need to integrate this information into ArcMap to create a thematic map.

*To achieve this you must conduct a **Table Join**. A table join appends attributes of a non-spatial table, to the attributes of a map table. (Non-Spatial means "without geography", i.e.: without map attached). In order for this join to be successful there must be a way to match records in one table with appropriate records in another. This is done with an attribute common to both, such as a name or ID code.*

Data Integration

1. Open a new session of ArcMap. From your Lab07 folder, add the layer "LLP_Pop05.shp".

2. Right click on the "LLP_Pop05.shp" file to open the "Attribute Table". This table contains some basic demographic information, including population count and population density.

3. Open Microsoft Excel. Go to File > Open > navigate to your Lab07 folder and open the file: "nso_census_2005.xlsx"

4. You will see that this table has more population variables disaggregated by age group.

5. If you intend to permanently save joined table to the shapefile make sure that the table is formatted correctly with only 11 characters for each variable name.

6. Once you have formatted the excel file, save into your Lab07 folder, **close excel and return back to ArcGIS.**

7. From Lab07 folder add the excel file "nso_census_2005.xlsx" and select 'nso_census_2005$' sheet.

8. Right-click on your "'nso_census_2005$" table to open it. Make sure that all field names carried through correctly, and that all data appears in working order. If it looks good, close the attribute table and move on!

9. The next step is to join the "'nso_census_2005$" table to the "LLP_Pop05" layer so that you can utilize its spatial properties to visualize the population info.

It is always preferable to use codes, rather than place names to conduct joins. Place names can vary in spelling and accent (which contribute to the unique nature of a particular name), and these may not always transfer from one software to another.

10. In this case, the joining variable is called “GEOCODE”.

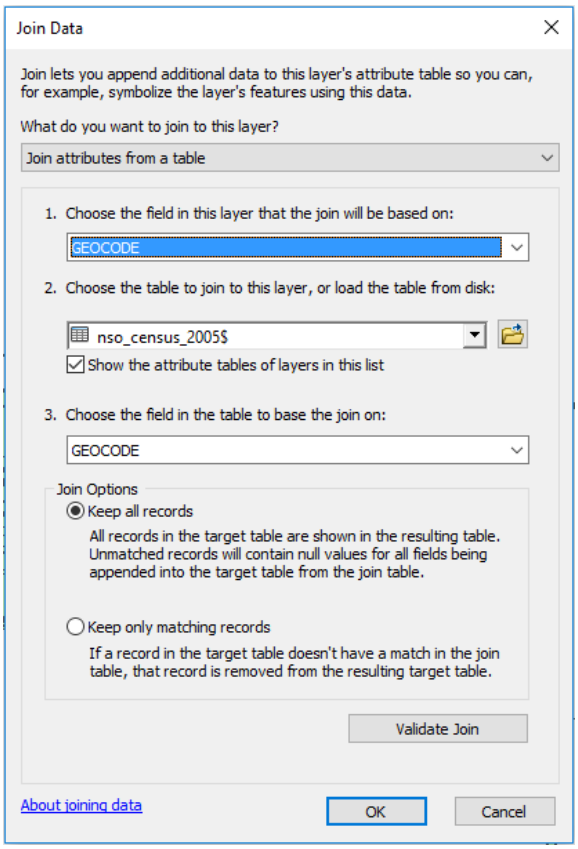
11. Right click on the “LLP_Pop05” layer, Scroll to “Join & Relates” > “Join”. Make the following dropdown selections, and click OK.

12. When complete, open the attribute table of the “LLP_Pop05” layer to make sure the join was successful. If you see fields that say <null>, in some cases it may be okay as data may not collected for the specific area BUT in some other cases the unique ID used to join may not match properly.

13. Before continuing, save your map to your Lab07 folder as “Lab07_YOURNAME”.

14. Double click on “LLP_Pop05”. The “Layer Properties” Window should now pop-up. If the tab “Symbology” is not selected, then select that tab.

15. In the box labeled “Show”, select the option “Quantities”, and click on the sub-option “Graduated Colors”.



16. In the drop down menu “Value:” **scroll to the end of the list**, and choose the field named “TOTPOP”: This stands for total population.

    **The variable labels follow a pattern, and are disaggregated by ages and gender. Note that each group of variables are labeled as such:

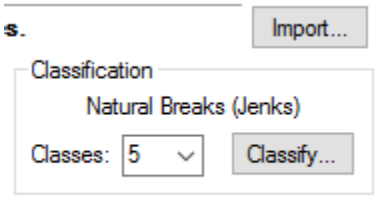
    - TOTMAL & TOTFEM: Male and female all ages respectively
    - POP_15TO19: Total population between 15 & 19 ages
    - MAL_15TO19: Male population between 15 & 19 ages
    - FEM_15TO19: Female population between 15 & 19 ages
    - POP_15TO49: Total population between 15 & 49 ages
    - MAL_15TO49: Male population between 15 & 49 ages
    - FEM_15TO49: Female population between 15 & 49 ages

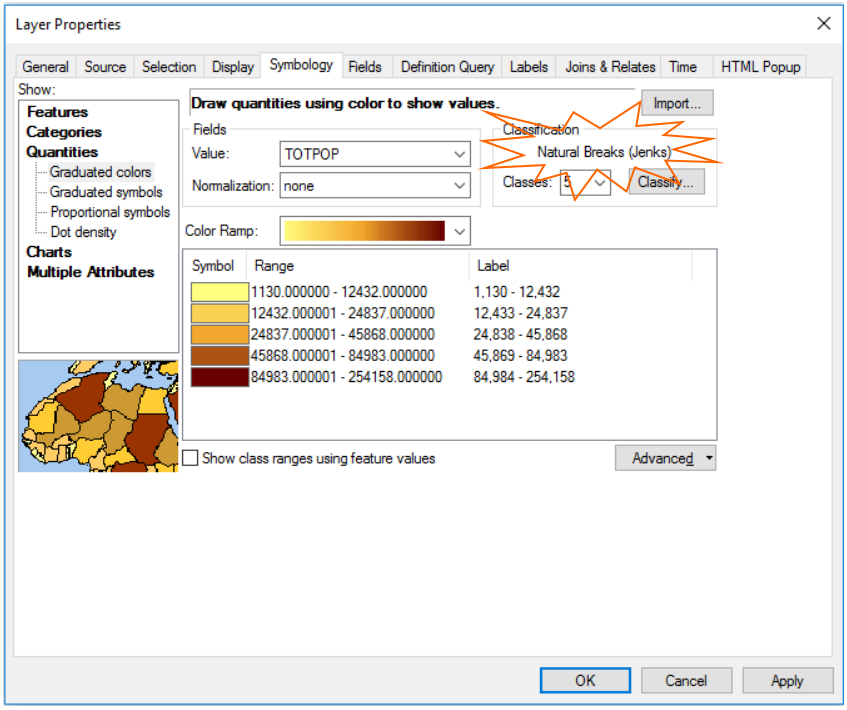
      …….

17. Once this field has been selected, choose a color ramp that you like by clicking on the down arrow next to the color ramp. Now click, Apply, and OK.

18. Look at how the colors are distribued. The classification brackets chosen by ArcMap are based on their default statistical classification; “Natural Breaks”.

19. Reopen the “Layer Properties” dialog for the “LLP_Pop05” layer. Return to the symbology tab. Under the Classification menu (top right-hand corner), Click the “Classify” button.

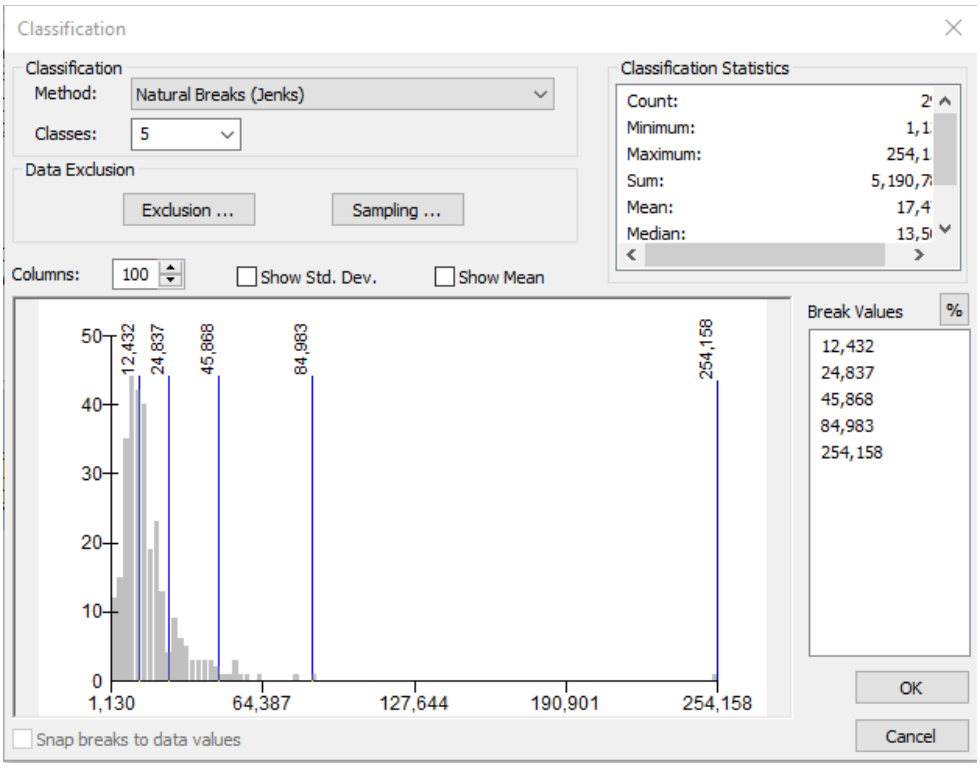




20. In the “Classificaton Wizard” you will see a histogram illustrating the data distrubution along the number line.

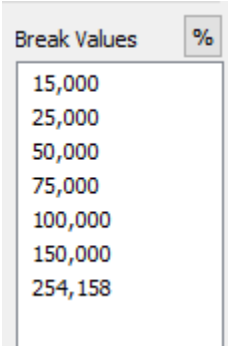
21. In the “Method” drop down list, you will see several classification alernatives to the “Natural Breaks” system. You also have the opportunity to change the number of classes that you use. *(See graphic below)*

22. Experiment with the different classification schemes, and look at how they alter the classification breaks (blue lines) on the histogram data. By clicking OK on both wizards, you will see the effect of your class scheme changes on the map itself.



23. For something as simple as population count, “Natural breaks” is not a bad starting point. To make the interval ranges a little more “user friendly” it is advisable to begin with “Natural Breaks”, then switch to “Quantiles”, and modestly round up/down the break values of each category.

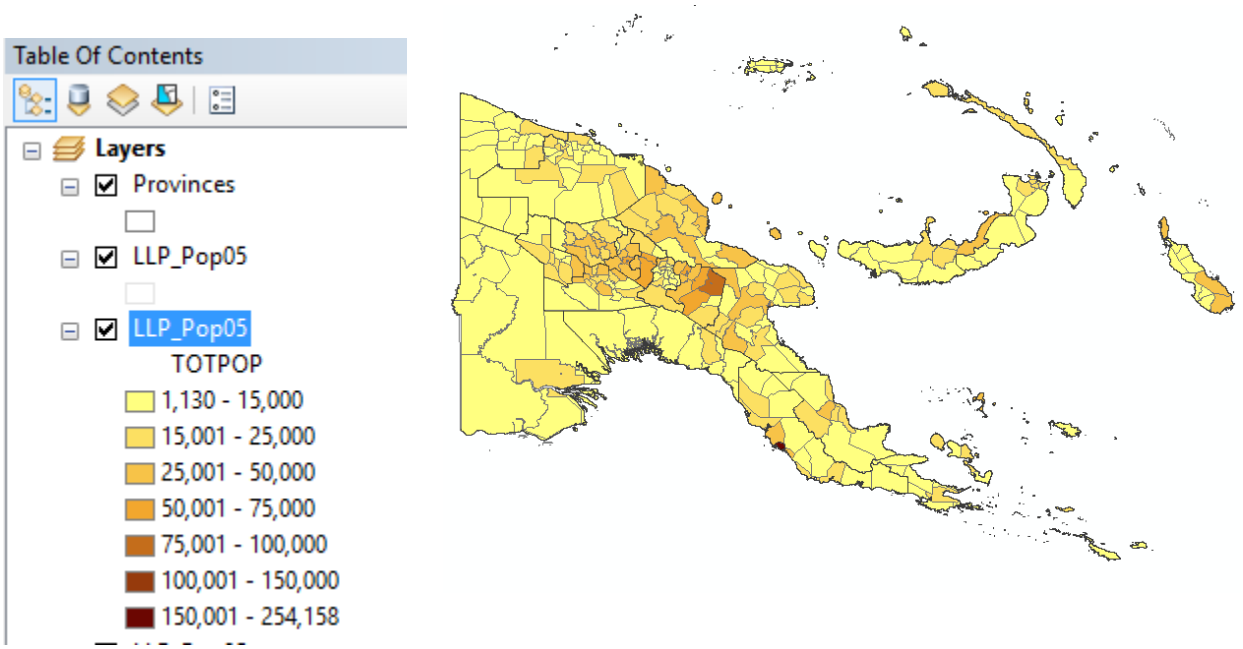
24. Obviously, this decision will be determined by the nature of your data, and a classification method such as “Standard Deviation” may be more appropriate in certain cases.



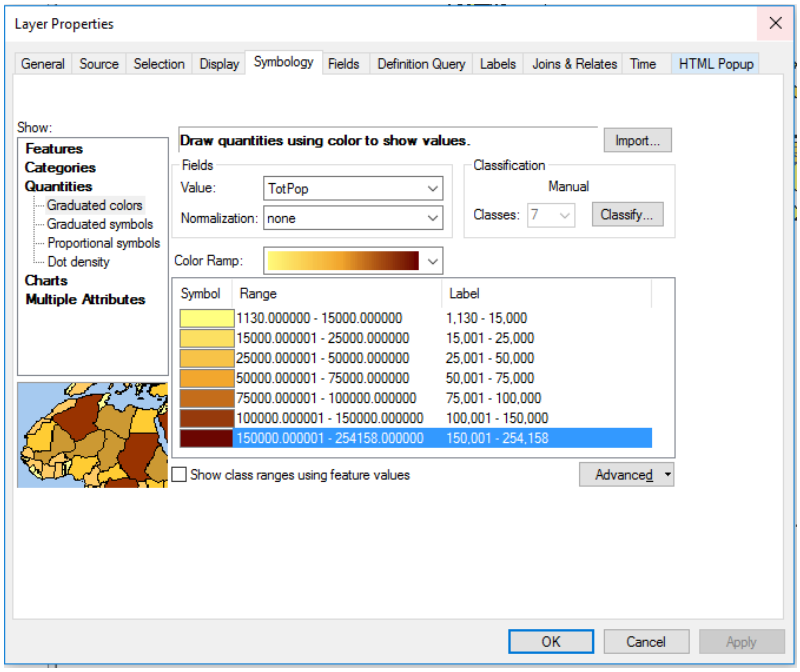
25. Return to the “Classification Wizard” screen. Choose first the “Quantiles” scheme, next change the number of classes to 7.

26. In the “Break Values” box to the right-hand side of the wizard, set the break values to the following numbers, by simply typing over the existing values.

27. When done, click OK. Now you are back at the “Symbology” window. The “Label” side of the menu will reflect the changes that you make to the “Range” side, but you may also use text in your labels.

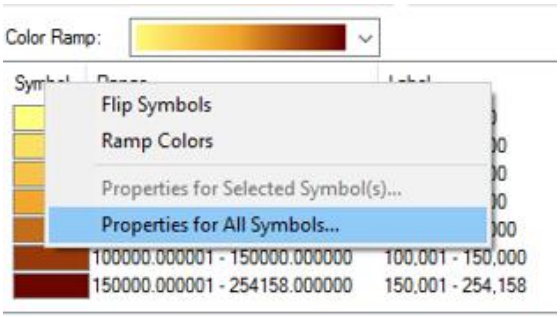


28. Now return back to your "LLP_Pop05" layer with the table join. Double click on the layer and return to the Symbology tab.



29. Modify the label options with some additional text, and commas by clicking on the value under the Label column. (This will determine the look of your legend, and reads better than the default categories).

30. For a softer subtler style, you will remove the boundaries from between the individual LLP. Click on the word "Symbol" above the colored category symbols, and in the pop-up menu, choose "Properties for all symbols". (see right)



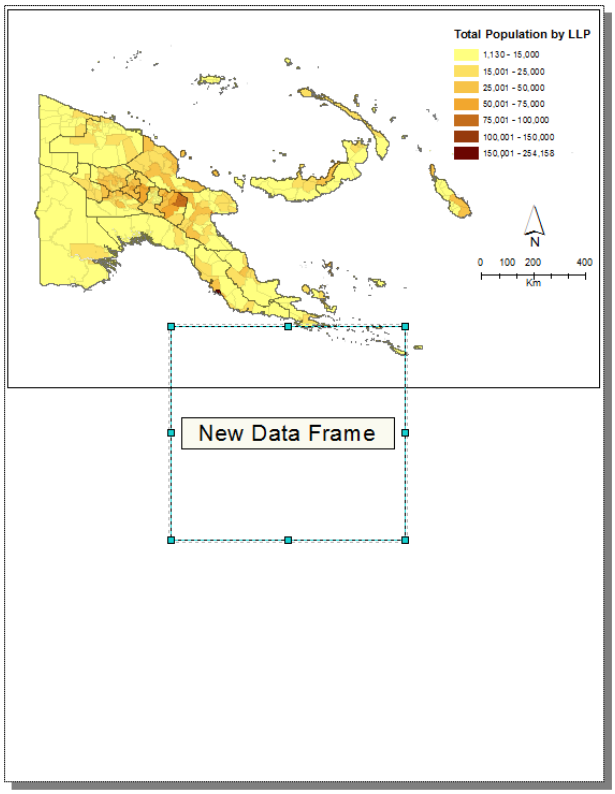
31. In the "Symbol Selector" dialog, change the outline color to "No color".

32. Click OK.

33. To distinguish the boundaries of the higher order administrative units, add the

"Provinces" layer from the Lab01 folder, and symbolize as hollow with an appropriate outline thickness. Remember how to do this? (hint: double click on colored box symbol below the layer name in the Table of Contents)

34. Switch to the layout view, by clicking on the layout symbol in the bottom left and corner of the map window.



35. Using the "Insert" menu, add a legend, and other appropriate cartographic elements to your map (North Arrow, and simple scale bar)

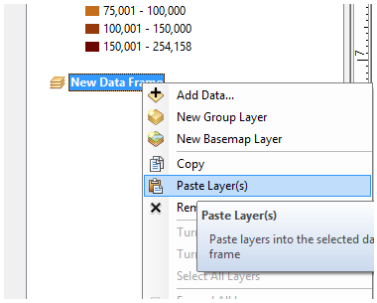
36. Save your map if you haven't recently!

37. In the layout window, resize the map, so that it is roughly one-half the size of the page by clicking once on the map and then dragging one of the corner sizing squares to diminish the size of the map. (You will also have to resize the legend and other elements). Move them to the top right hand corner of your layout.

38. From the "Insert" drop down menu, choose the "New Data Frame" option. This will add a new empty map window to your layout. (see below)

39. Now to add data to your new map window. In the table of contents, right-click on the "LLP_Pop05" layer in your first Data Frame that you have been working with up until now and scroll to "Copy".

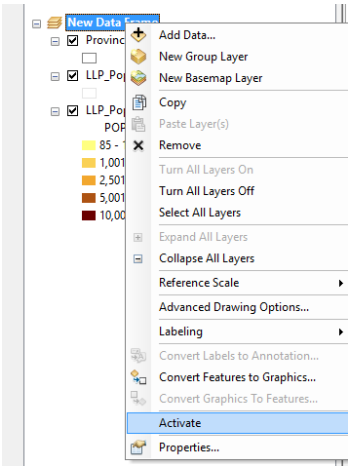
40. Now right-click on the "New Data Frame" listing and scroll to "Paste". Repeat the process to add the "Provinces" layer to your second map window.



41. Right now, each window looks identical. To help distinguish between the windows, double click on the "LLP_Pop05" layer for your new map (leave the first map as is) and return to the "Symbology" tab of "Layer Properties". In the "Show" box click once on the word "Quantities", and then "Graduated Colors". In your "Value" drop down list, choose any of the variables you are interested in the drop down list. You can choose a specific age group, or if you want, to aggregate population at a specific age group, you can add a field and sum columns. I chose "POP_15TO49" to map "total population of ages between 19 &49", but it may be interesting to look at male versus female population.

42. Once you have chosen your variable, press OK to map that variable and see how it looks spatially across the LLP of PNG. How does it vary from your other map?

43. In a multi-map set-up such as this. Only one map may be considered “Active” at any given time. This means that you can only work on the elements of one map at a time. To “Activate” a map, you can simply click on it in the layout view, or, you can right-click on the title of its corresponding set of layers in the table of contents, and scroll to “Activate”.

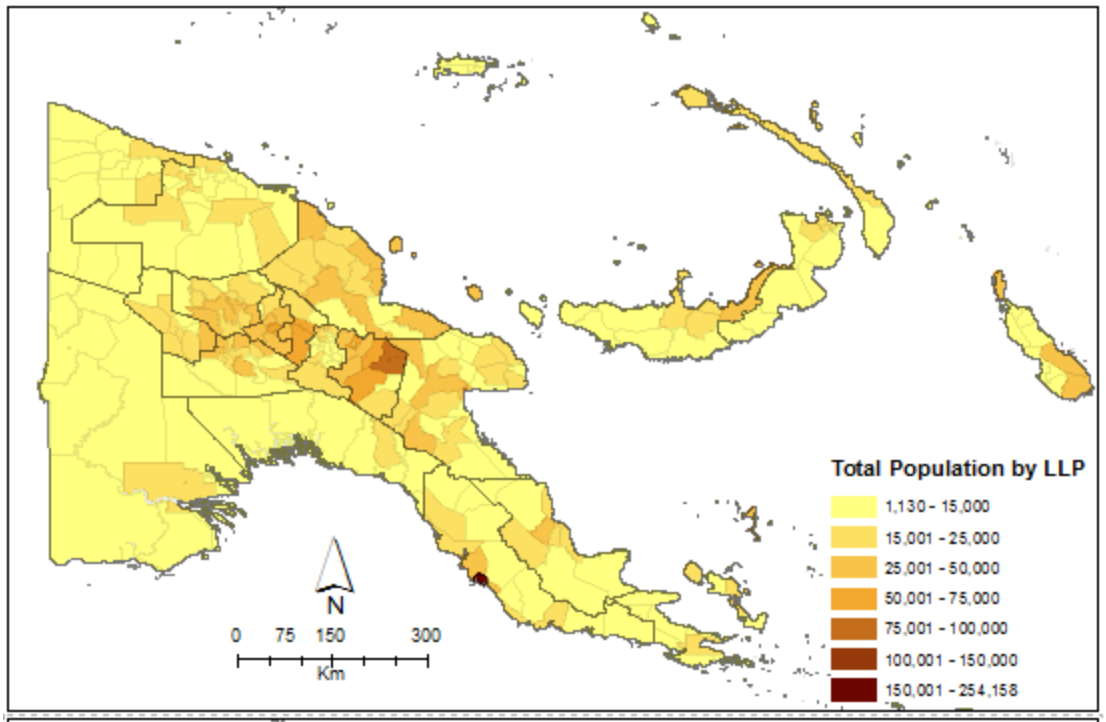


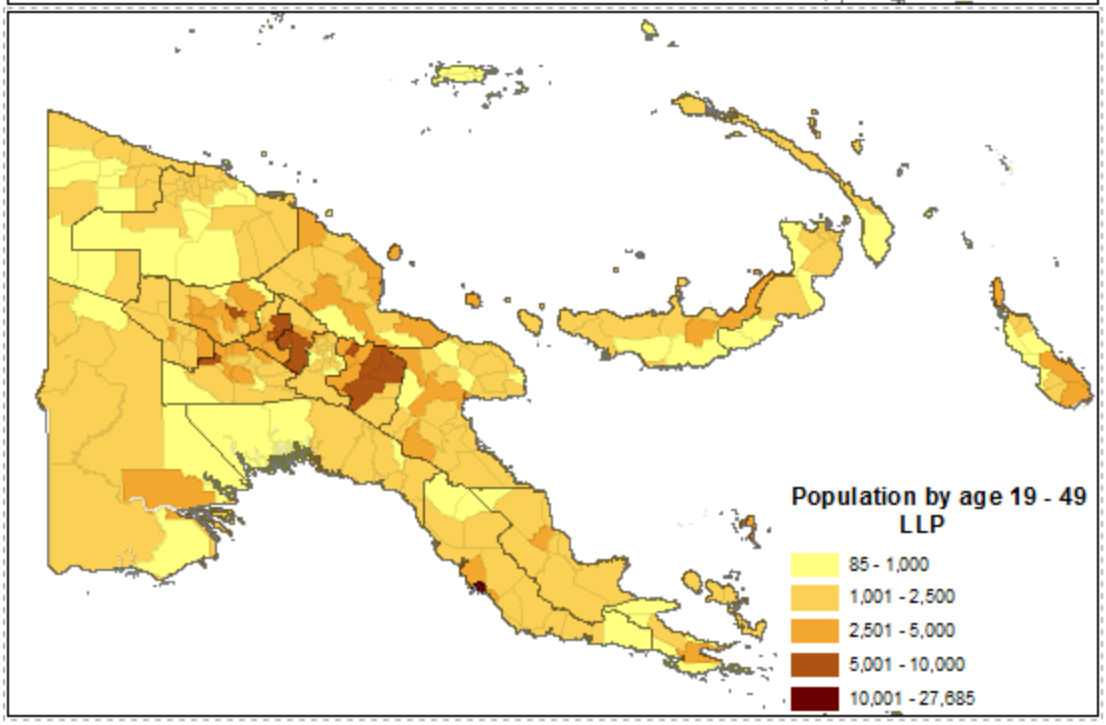
44. On switching to the “Data View”  , you will notice that only the active map is shown.

45. Test this by switching to the “Data View” and activating (from the table of contents) each map in turn.

46. After understanding varying “Data View” interfaces, put the final touches on the maps that you chose to make and export them as a .jpeg by going to the “File” button in the upper, left corner. Scroll to export and save as .jpeg in your Lab07 folder!

Your layout window should now look something like this (of course yours may be mapping different variables):


Total Population by LLP
1,130 - 15,000
15,001 - 25,000
25,001 - 50,000
50,001 - 75,000
75,001 - 100,000
100,001 - 150,000
150,001 - 254,158
N
0 75 150 300
Km


Population by age 19 - 49
LLP
85 - 1,000
1,001 - 2,500
2,501 - 5,000
5,001 - 10,000
10,001 - 27,685

Lab 08 – Agricultural system mapping

Exercise Overview
For this exercise partial spatial database of the Papua New Guinea Agricultural System project, comprises variety of data on agricultural crops and practices on small holder (subsistence) farmers, provided to create maps of dominant staple crops and sub dominant staple crops.

*From the six types of agricultural system categories (Fallow system, fallow period, cultivation intensity, **staple crops**, garden and crop segregation and soil fertility), this exercise focuses on mapping the distribution and pattern of staple crops in PNG. To achieve this, you will be joining the spatial data and table that describes the coded value in the database.*

Data Integration

1. Open a new session of ArcMap. From your Lab08 folder, add the layer "dist_agrisys.shp".

2. Right click on the "dist_agrisys.shp" file to open the "Attribute Table". This table contains agricultural system variables and values.

3. Open Microsoft Excel. Go to File > Open > navigate to your Lab08 folder and open the file: "Domstap_legend_desc.xlsx"

4. You will see that this table has DOMSTAP codes and descriptions

5. If you would like to keep this legend description permanently saved in to the shapefile along the code, make sure to format the table with only 11 characters for legend description field.

6. Once you have formatted the excel file save into your Lab08 folder, **close excel and return back to ArcGIS.**

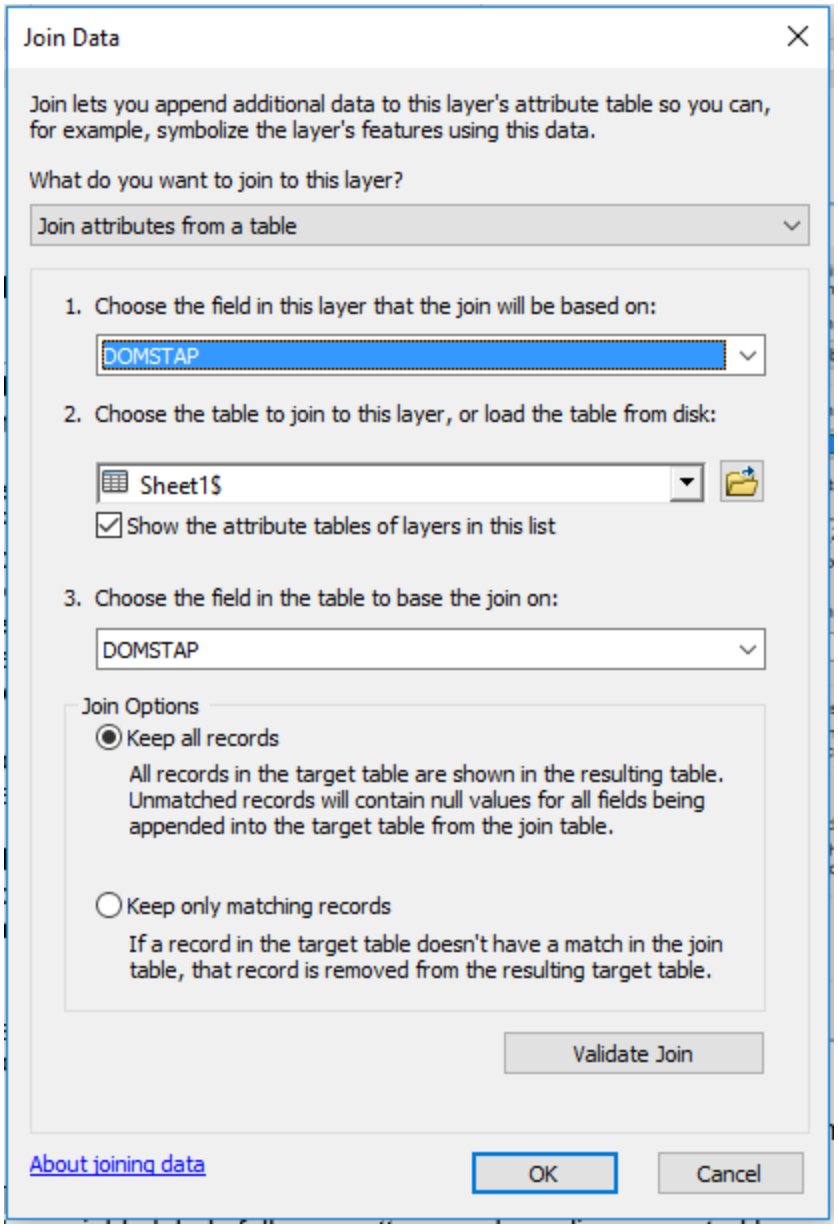
7. From Lab08 folder add the excel file "Domstap_legend_desc.xlsx"" and select 'Domstap_legend_desc$' sheet.

8. Right-click on your "Domstap_legend_desc$" table to open it. Make sure that the legend description field name carried through correctly, and that all data appears in working order. If it looks good, close the attribute table and move on!

9. The next step is to join the "Domstap_legend_desc$" table to the "dist_agrisys" layer so that you can utilize its spatial properties to visualize the population info.

10. In this case, the joining variable is called “DOMSTAP”.

11. Right click on the “dist_agrisys” layer, scroll to “Join & Relates” > “Join”. Make the selections as seen in the picture (right) and click OK.



12. When complete, open the attribute table of the “dist_agrisys” layer to make sure the join was successful. If you see fields that say <null>, in some cases it may be okay as data may not collected for the specific area; BUT in some other cases the unique ID used to join may not match properly.

13. Before continuing, save your map to your Lab08 folder as “Lab08_YOURNAME”.

14. Double click on “dist_agrisys”. The “Layer Properties” Window should now pop-up. If the tab “Symbology” is not selected, then select that tab.

15. In the box labeled “Show”, select the option “Categories”, and click on the sub-option “Unique values”.

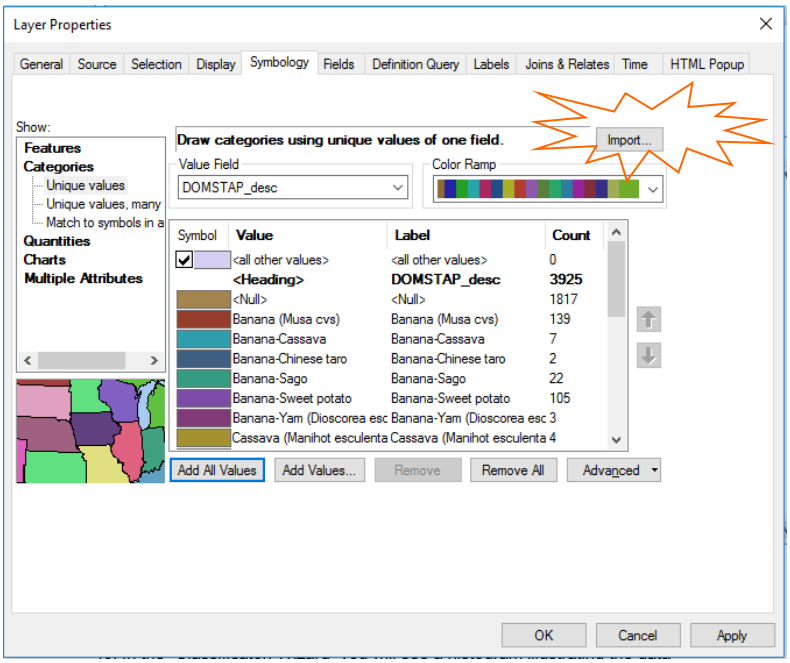
16. In the drop down menu “Value:” scroll to the end of the list, and choose the field named “DOMSTAP_desc”: This stands for dominant staple crops description.

The Dominant Staple Crops [DOMSTAP]: defined as the most important staple food crops grown in the subsystem. A major staple is defined as a crop estimated to cover more than one-third of staple garden area, and therefore no more than 3 dominant staples may be identified for a system. An important exception occurs when sago is the staple. Sago is extracted from palms which are not cultivated in gardens. In the text accounts (System Summaries and Notes), dominant staples are described as the 'most important crops'.

17. Once this field has been selected, choose a color ramp that you like by clicking on the down arrow next to the color ramp. Now click, Apply, and OK.

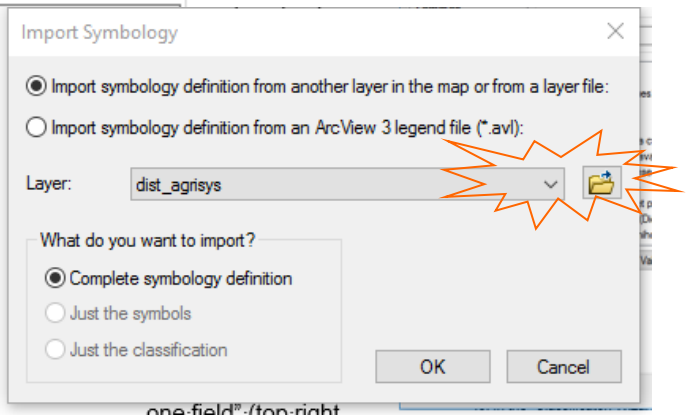
18. Look at how the colors are distribued. The unique classification reveals types of dominant staple crop types.

If you would like to use a readymade classification layer

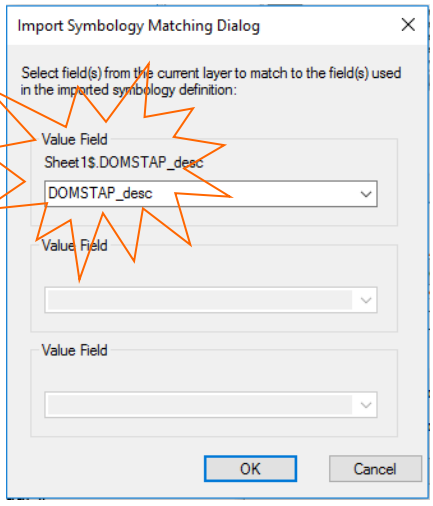


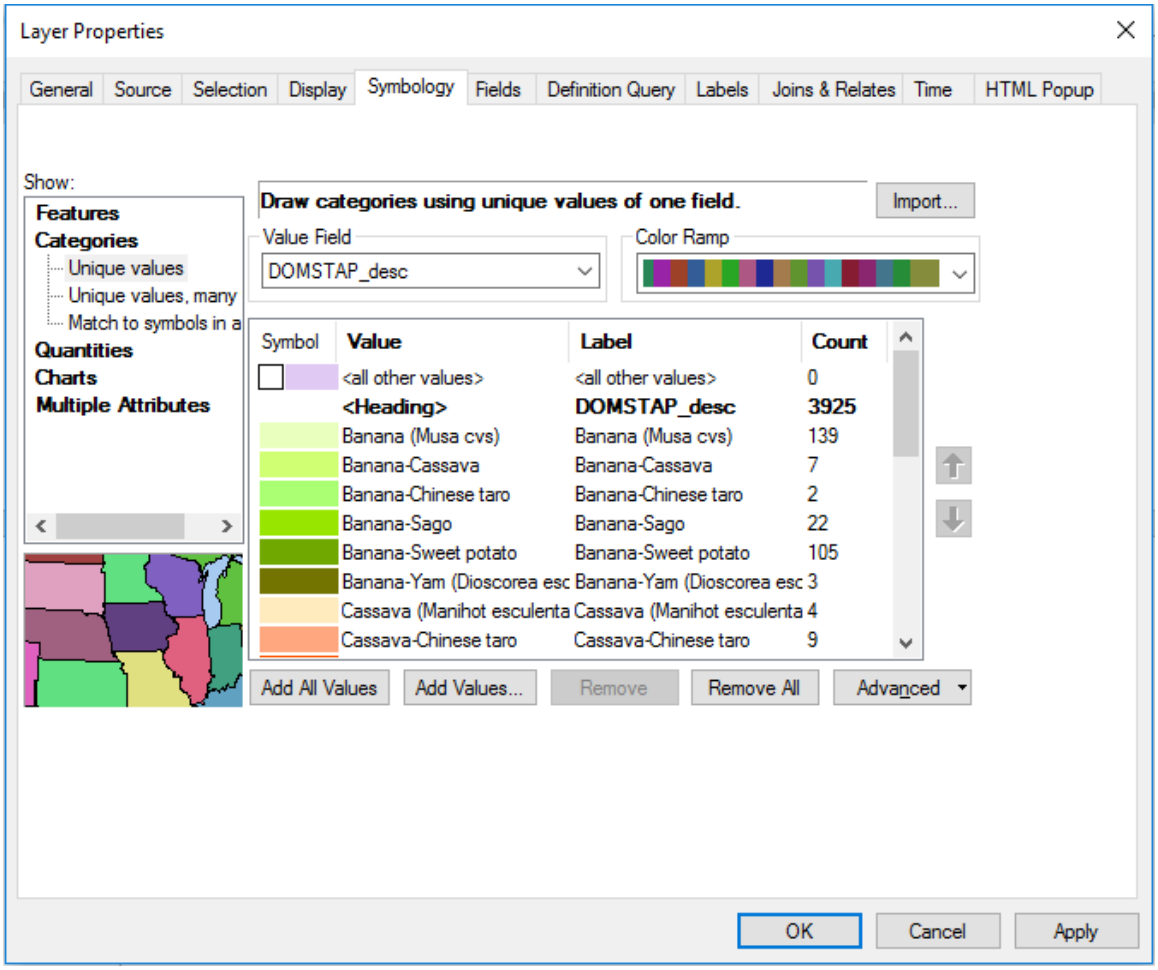
19. Reopen the “Layer Properties” dialog for the “dist_agrisys” layer. Return to the symbology tab. Under ‘Draw categories using unique values of one field” (top right-hand), Click the “import” button.

20. In the Import Symbology” click open folder symbol to import readymade legend stored in Lab08. Select ‘AgSystem_lengend.lyr” and click add.

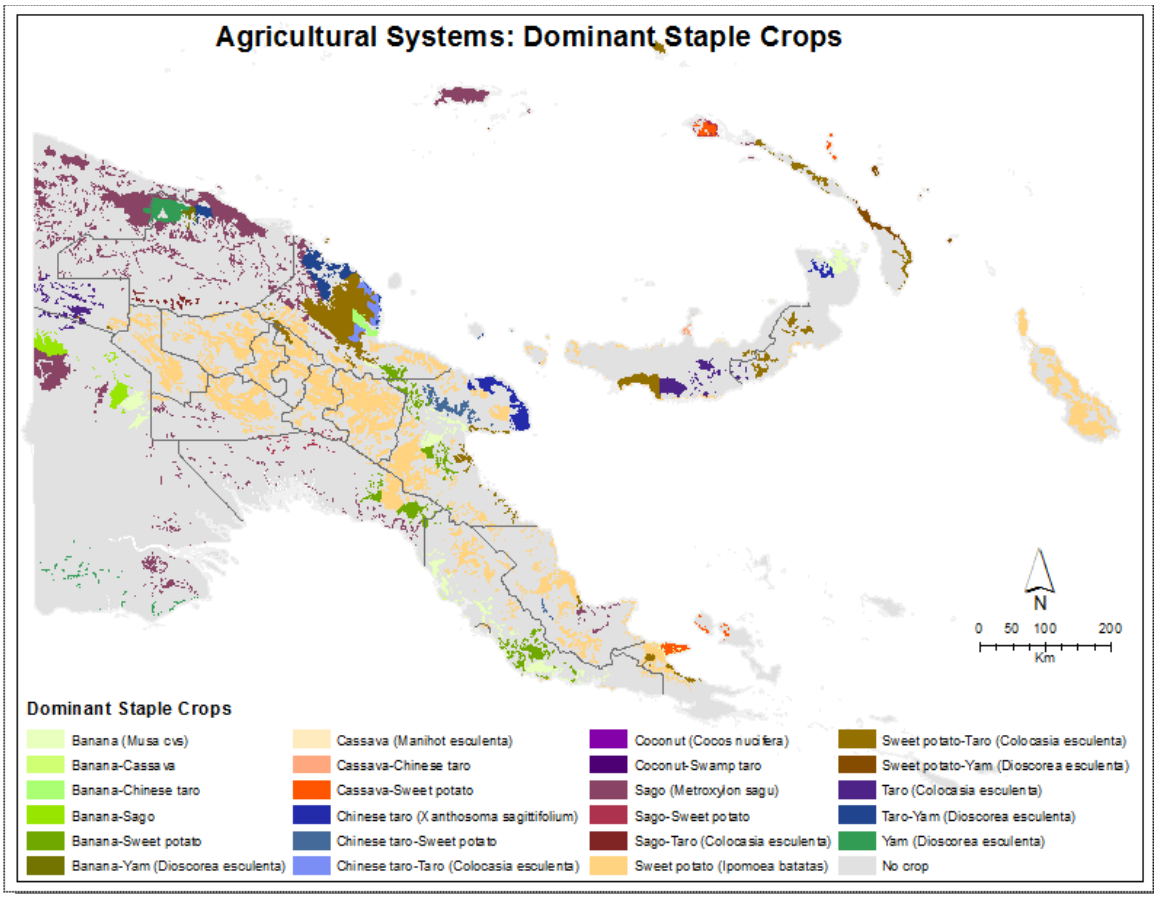


21. In the ‘Import Symbology Matching Dialog’ make sure the value field being used to match the layer is “DOMSATP_desc” and click OK.

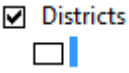


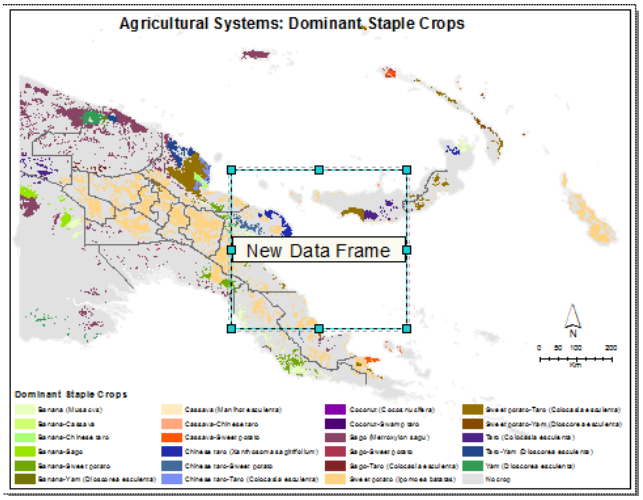


22. You will have a classification as dipcited in the picture above. Next, create a map following the steps completed in the earlier labs and come up a map similar to the map below.



Now create dominant staple crop maps of survey districts and overlay surveyed community locaiton.

23. From Lab08 add “survey_community” gps data.
24. To locate survey districts, from Lab01 add districts and in the table of contents click on a rectangular box right beneath Districts layer  which opens up ‘symbol selector’ dialog box and choose the boundary hollow.
25. From the “Insert” drop down menu, choose the “New Data Frame” option. This will add a new empty map window to your layout. (as seen in the figure-below)

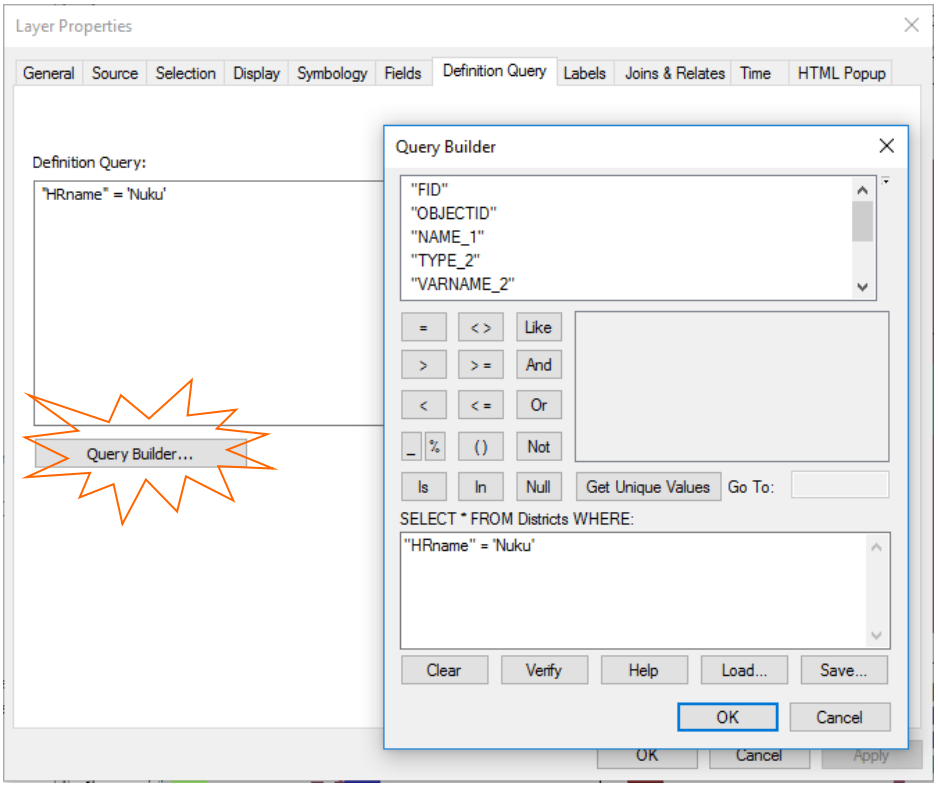


26. Add province data to your new map window. In the table of contents, right-click on the “Provinces” layer in your first Data Frame that you have been working with up until now and scroll to “Copy”.

27. Now right-click on the “New Data Frame” listing and scroll to “Paste”.

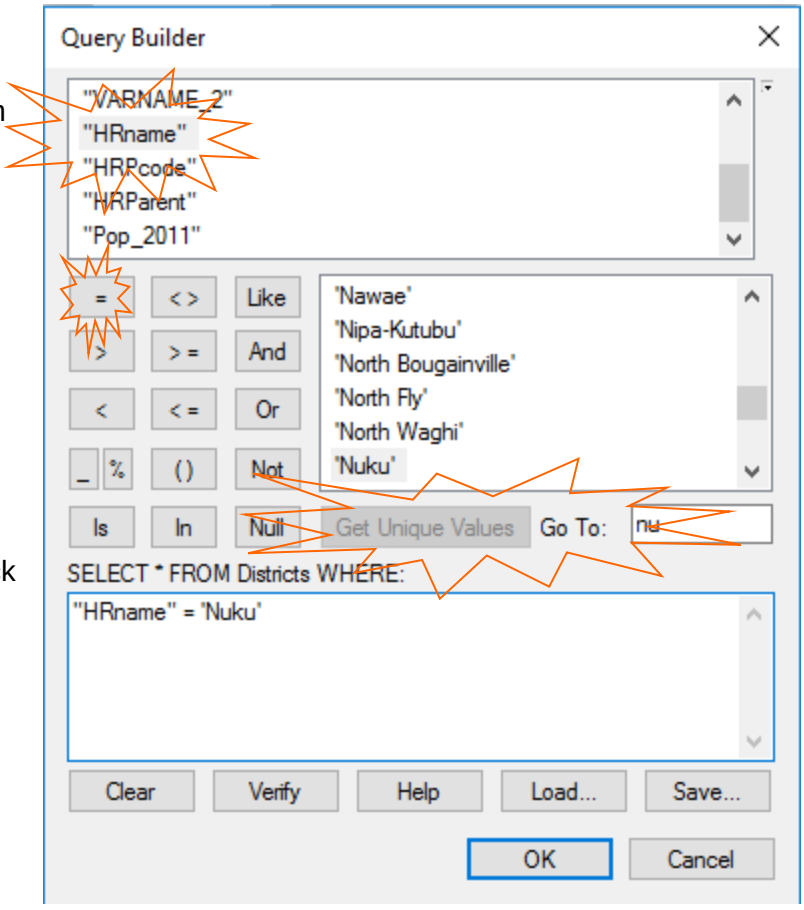
28. Resize and locate at the top-right corner of the map so that it fits within the printable area.

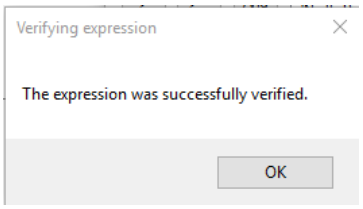
29. Now, let’s select districts where the survey undertaken. Doboule click on ‘districts’ layer and click ‘Definition Duery’ tab.



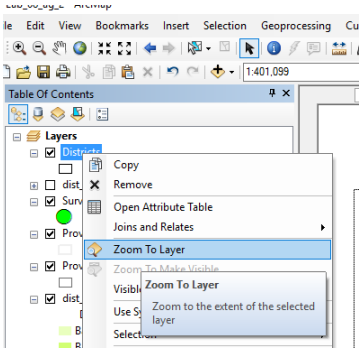
The survey conducted in Sandaun, East Sepik, Madang and Bougainville provinces mainly in and around Nuku, Maprik, Middle Ramu and South Bougainville districts. So to create large scale mapping that display a specific survey site select districts where surveyed communities located. For this particular example, select zoom to "Nuku" distrtrict and see the distribution of survey communities against agricultural system map.

30. While 'Definition Query' tab selected on Layer properties window click "Query Builder". From the variables listed in "Query Builder' scroll to 'HRname' and double click it. That throws it to "SELECT *FROM Districtis WHERE" query window.
31. From the list of logical operators double click [=].
32. Click on 'Get Unique Values' tab and type 'nuku'. The actual 'Nuku' value will show up in the value list of HRname field. Double click 'Nuku' from the list.
    To verify if your syntax is valid, click verify.

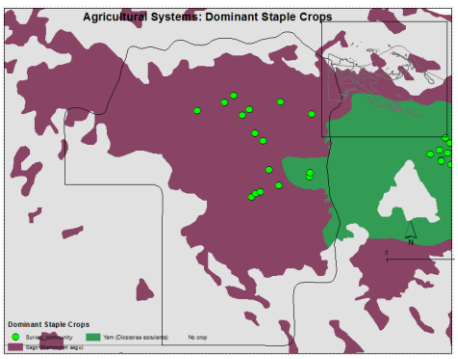




33. If your query is successful, at this point only 'Nuku' district boundary is visible. Now, right click 'districts' layer from the table of content click zoom to layer



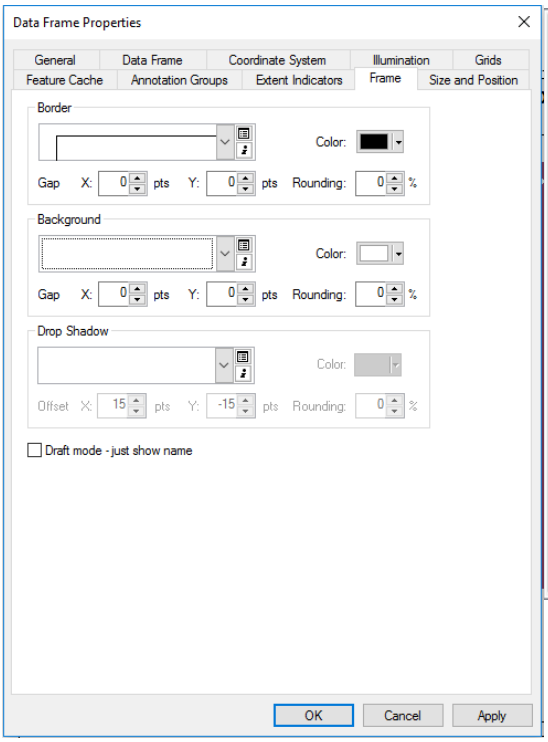
34. You can see communities surveyed in Nuku district. For final map creation change the inset map and legend properties.

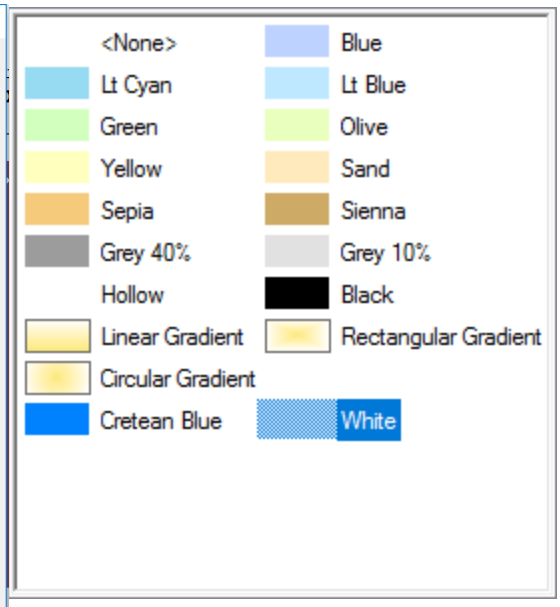


35. To change the inset map click the inset map and Properties.

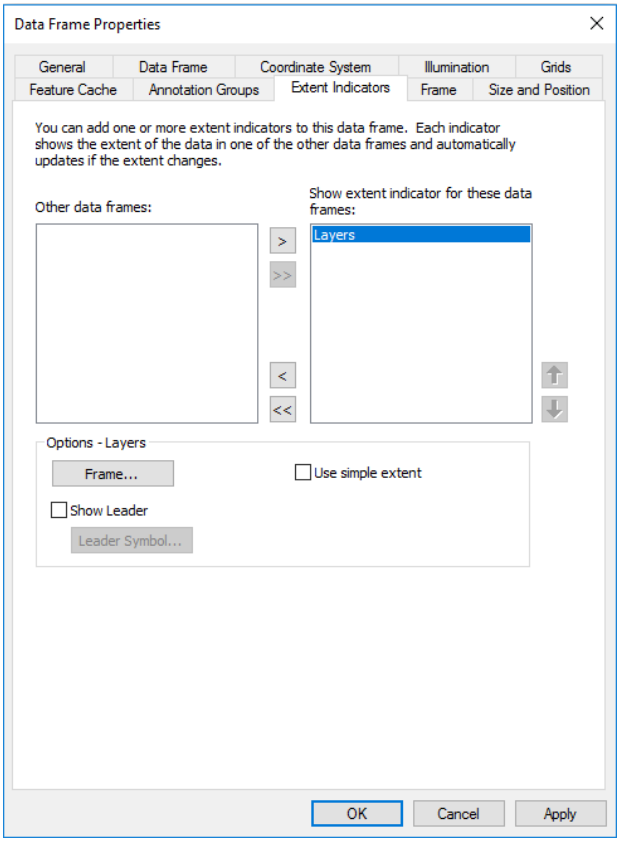
properties, right point to

36. Select “Frame” tab and click the drop down under ‘Background’ and select ‘white’ and click Apply.

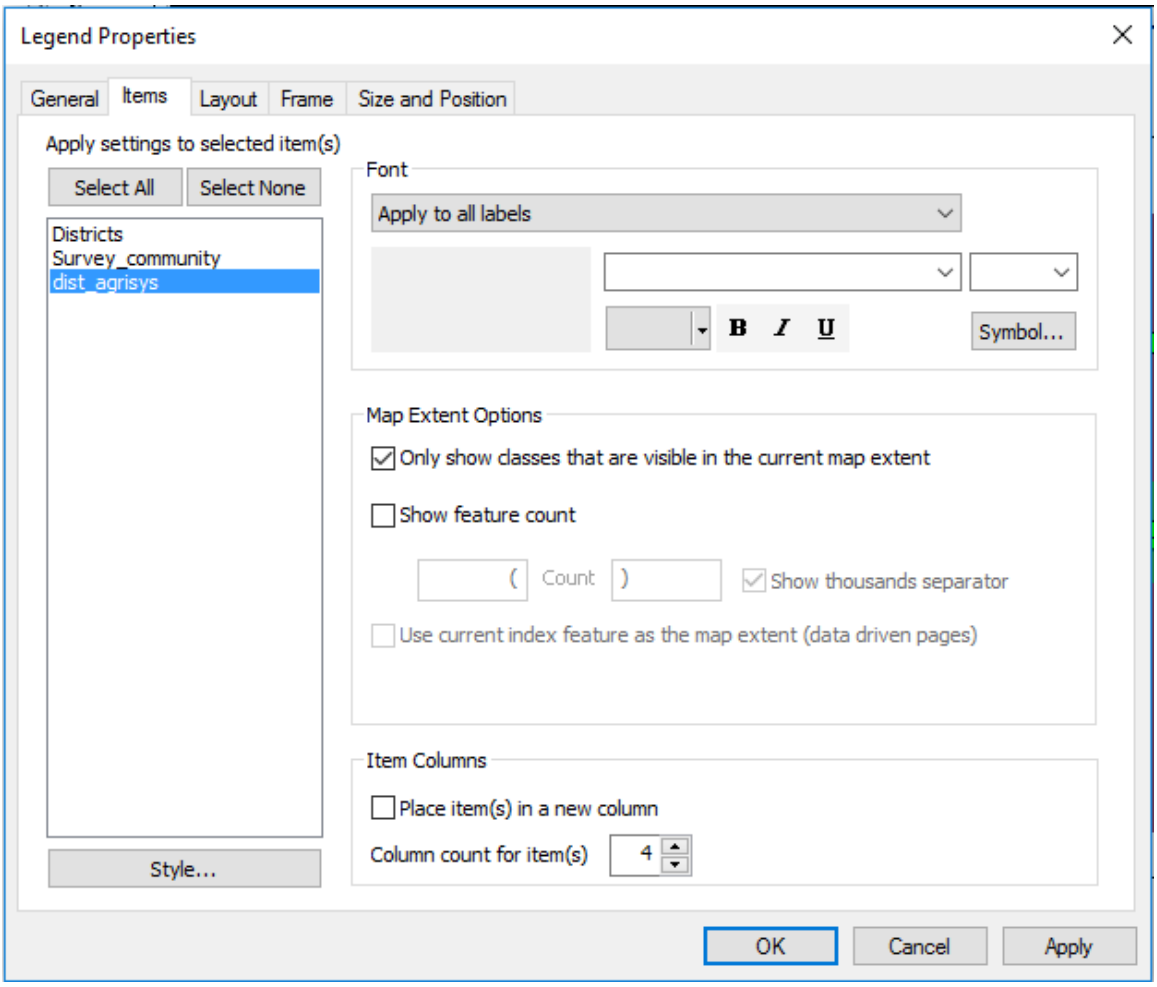




37. While in ‘Data Frame Properties’ click ‘Extent Indicator’ tab. Select ‘Layers’ from ‘Other data frames’ and click > and Apply.(see picture-right)



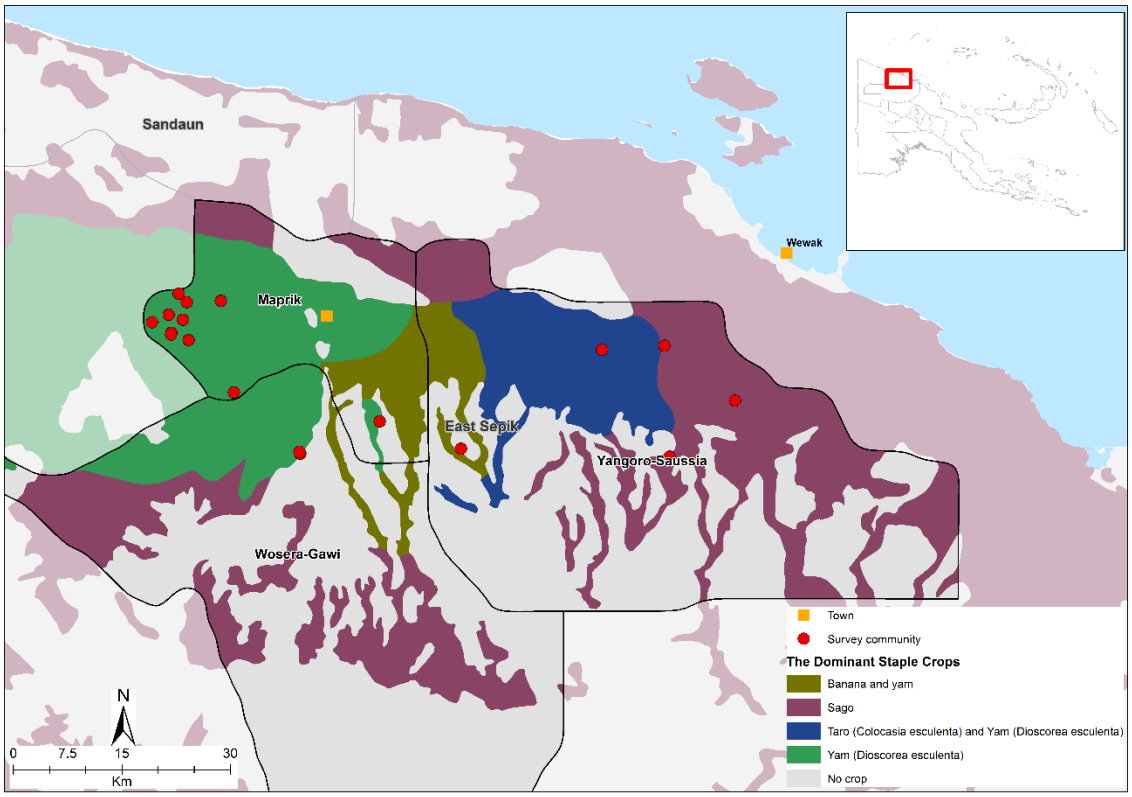
38. Next, let's change legend properties so that it only shows classes that are visible in the current map extent. Double click legend from the map to get 'legend Properties' window. Click 'Items' tab and select 'dist_agrisys' layer. From 'Map Extent Option' tick the square box next to "Only show classes that are visible in the current map extent' and click apply.



39. Save your map if you haven't recently!

40. Your layout window should now look something like this (of course yours may look different):

41. Put the final touches on the maps that you chose to make and export them as a .jpeg by going to the "File" button in the upper, left corner. Scroll to export and save as .jpeg in your Lab08 folder!


Sandaun
Wewak
Maprik
East Sepik
Yangoro-Saussia
Wosera-Gawi
N
0
7.5
15
30
Km
Town
Survey community
The Dominant Staple Crops
Banana and yam
Sago
Taro (Colocasia esculenta) and Yam (Dioscorea esculenta)
Yam (Dioscorea esculenta)
No crop