

## MAPPING EXERCISE

### Thematic Mapping: The Choropleth Map

One of the most widely used thematic maps is the choropleth map. In this technique, symbols represent *areas* for which data has been collected. Thus, the technique is sometimes called enumeration mapping. Typical enumeration areas used for this technique include administrative areas such as countries, states, provinces, counties, and census tracts.

There are two forms of the choropleth technique: the *conventional choropleth technique* and the *unclassed choropleth technique*. In the conventional technique, data values are grouped into classes. Each class is symbolized with a unique areal symbol. In the unclassed technique, *each value* is symbolized by its own unique areal symbol. In this exercise you will employ the conventional choropleth technique.

### Key Considerations of the Choropleth Technique

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***The subject of the map.*** Areas are the basic map units of the choropleth technique. Do not map phenomena that are continuous in nature (e.g., temperature, atmospheric pressure). Rather, select phenomena that conform to political or administrative boundaries. Because one symbol is used for the entire enumeration unit, there is an assumption that the data area distributed uniformly throughout the area. Consider choosing an alternate thematic technique when a phenomenon is confined to a few locations within the enumeration unit, especially if totals are being mapped.

***Enumeration data.*** Data used in the choropleth technique are of two varieties: totals (counts) or derived values (ratios or rates). While both are frequently used, mapping totals is discouraged. The reason for this is that in most maps, enumeration units vary in size. Two concerns must be overcome when a map has enumeration unit areas that are quite small and quite large (e.g., a map of the states of the U.S.). First, comparison between unit areas is problematic as it is common for large areas to have more of the phenomenon in question merely as the result of their size. Second, large areas will convey a different impression than small areas within the overall distribution on the map. A large area with a small value may be visually more important than a small area with a large value simply because of the amount of relative space that area occupies.

***Classification.*** Data classification simplifies the data from hundreds, or perhaps thousands, of observations to a handful of groups (four to six classes is recommended) which are then symbolized on the map. Make sure that the symbols used to represent your classes are different enough so as not to create confusion for the reader. Refer to Chapter 5 of your textbook for a more detailed discussion of classification methods.

In this exercise, you will:

- ✓ Open a map project
- ✓ Create a new shapefile from an existing shapefile
- ✓ Set the map projection
- ✓ Join a data table to your map
- ✓ Formatting legend labels
- ✓ Apply and change color ramps
- ✓ Classify the map data
- ✓ View a histogram of your data
- ✓ Create a map layout

## Getting Started

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- Start ArcMap (**Start All Programs >ArcGIS >ArcMap**); if there is an icon on the computer desktop, you can start ArcMap by double-clicking it. You will be shown a window asking whether you want to open a new empty map, a template, or an existing map.
- Make sure the **An existing map:** radio button is selected and click OK. If you did not see this window, click **File >Open**.
- Browse to where you saved the **Choropleth.mxd** project file and open it. You will find one map layer: the Countries of the world.

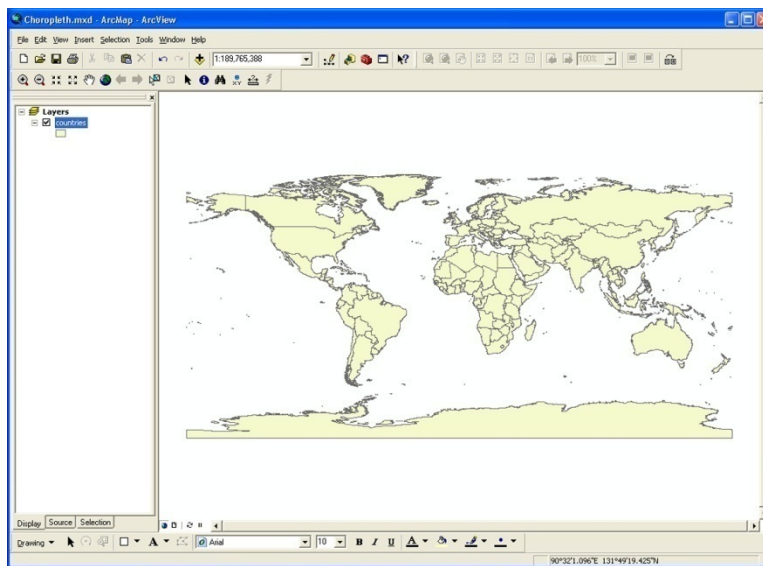


Figure 1. The Countries map layer.

In this exercise you will be making a map focusing on the countries of Europe. You will first select the European countries from the countries layer and create a new shapefile. You will then join a table to this file which contains the data you will map.

To select the European countries, you will use a field in the attribute table.

- Click **Selection >Select By Attributes**. The Select By Attributes dialog will open.
- Select the European countries by entering the following query in the **Select From** box: **"Region" = 'Europe'**. You may type this formula or enter it by (1) double-clicking on "Region" (2) single-clicking the equal operator (equals sign button), (3) clicking the Get Unique Values button to reveal the list of regions and (4) double-clicking 'Europe'.

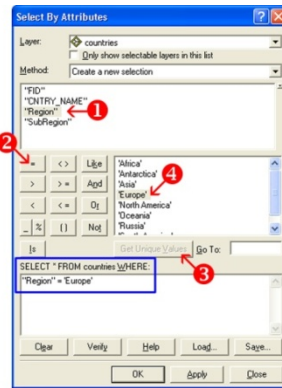


Figure 2. Selecting the European countries.

- Click **Apply** to accept the selection. Move the **Select By Attributes** window off to the side to confirm that the European countries have been selected (Figure 3).

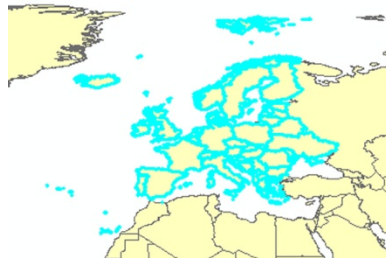


Figure 3. European countries selected from the countries layer.

- If you have properly selected the European countries, click **OK** to close the window and return to the data view.
- To create the new shapefile, **right-click countries** in the Table of Contents and select **Data >Export Data**.



Figure 4. Creating a new shapefile from your selected features.



When working with a subset of existing data, you do not *have* to create a new file from the original map layer. If you wish to merely display the European countries differently than all other countries, use **Unique values in Categories** and select **Europe** as the Value Field (Figure 5).

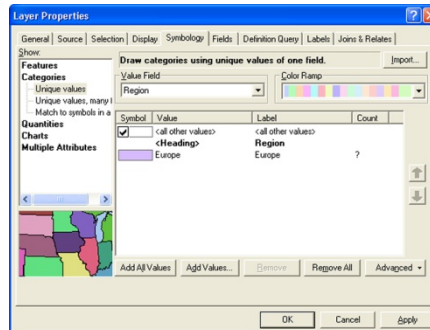


Figure 5. Using **Unique Values** to display the EU countries.

You may also use a **Definition Query** to display a subset of the data. In the layer properties window, select the **Definition Query** tab. Next, use the **Query Builder** to create an expression to identify the features you wish to display. You can then use the choropleth technique for this selected subset.

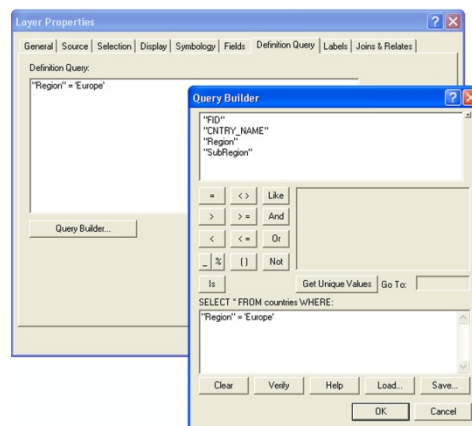


Figure 6. Using the Definition Query to display only the European countries.

It sometimes is advantageous to create a new map layer from an existing layer—especially if you will use this layer frequently and join or relate data tables in a wide range of mapping projects.

- In the export data window that appears, click the catalog browser button (file folder button) to select where you will save your file. Choose either the location from where you opened this project file or another location specified by your instructor.
- Name the file **Europe** and click **OK**.

You will be prompted whether you wish to add the exported data to the map as a layer.

- Click **Yes**.

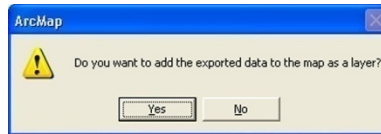


Figure 7. Click Yes to add the Europe layer to your project.

- If the European countries in the Countries layer are still selected, click **Selection >Clear Selected Features** to deselect them.

You should now have the Europe layer in the Table of Contents and in the Data View window.

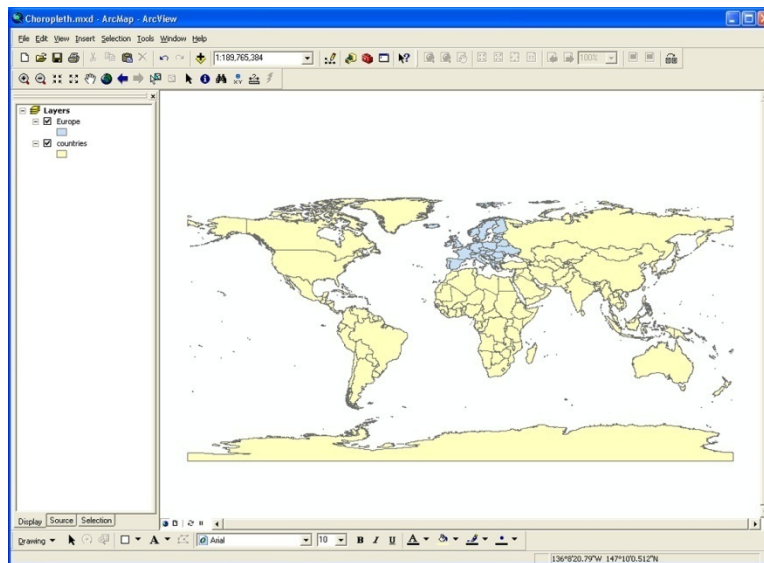


Figure 8. World map with the Europe layer.

The next step will be to project the map. You always should establish a projection for your mapped area. World projections, like the map currently has, are not suitable for mapping areas in the mid-latitudes or high latitudes.

- Right-click **Layers** in the Table of Contents and select **Properties**.
- Select the **Coordinate System** tab. Notice that your map currently has a defined coordinate system. You will be changing it to something more appropriate to Europe.
- In the **Select a Coordinate System** box select the following:
  - Predefined > Projected Coordinate Systems > Continental > Europe > Europe Lambert Conformal Conic

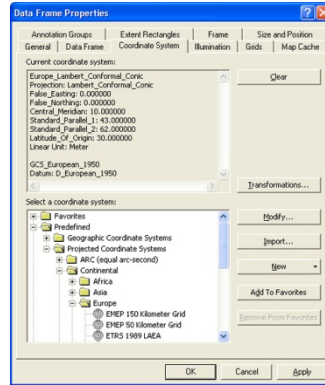


Figure 9. Selecting the Europe Lambert Conformal Conic Projection.

- Click **OK**

You may get a warning window explaining that the coordinate system you are using differs from that of your map data sources and you will be asked whether you wish to use this coordinate system anyway.

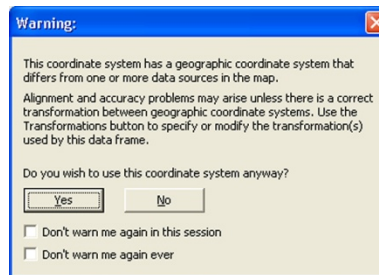


Figure 10. Warning window resulting from selecting the Europe Lambert Conformal Conic projection.

The warning message you received resulted from a mismatch in the original coordinate system defined for the country map layer (GCS WGS1984 datum) and the European Lambert Conformal Conic projection (which is based on the GCS European 1950 datum).

**i** ArcMap allows you to define coordinate systems for individual map layers (shapefiles) as well as to perform *on-the-fly projection*. With on-the-fly-projection ArcMap displays the map data with a new projection without altering the original data file. If on-the-fly projection results in possible misalignment, you will see the error message in Figure 10. Given that you are making a choropleth map at the scale of the western Eurasian landmass, the possible error is acceptable.

- Click **Yes** to accept the coordinate system you selected.

You will now have a map of the world which is badly distorted with increased distance from Europe.

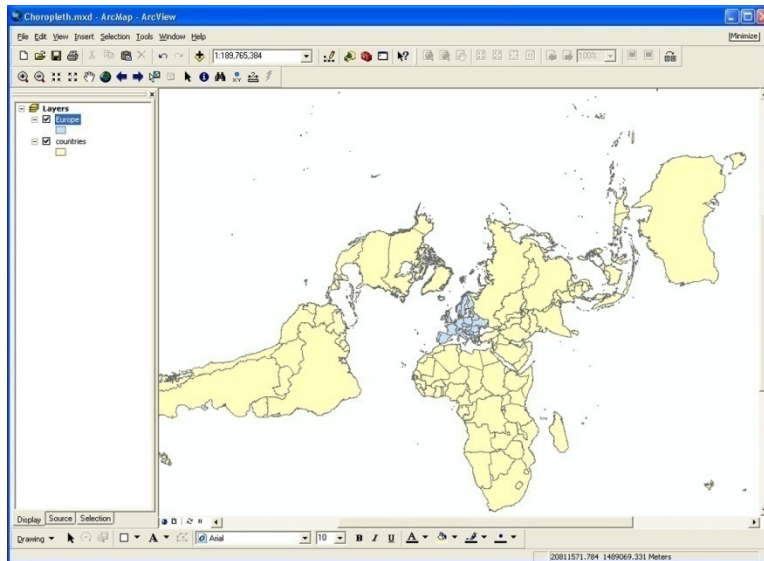


Figure 11. The world map using the European Lambert Conformal Conic projection.

- Next, **right-click** the **Europe** layer in the Table of Contents and select **Zoom to Layer**.
- Reposition the map as necessary with the **pan** and **zoom** buttons on the Tools toolbar so that the European countries fill the data view.

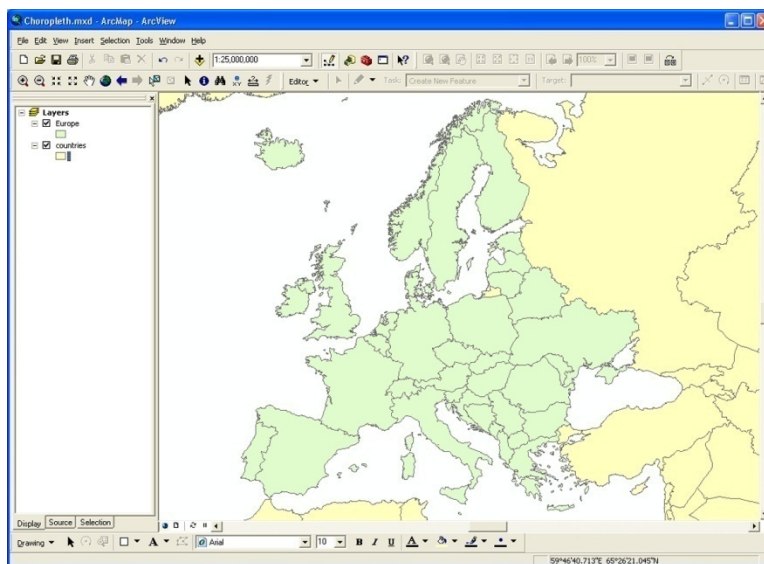


Figure 12. Your map zoomed to the Europe layer.

The next step is to load the data that you will map using the choropleth technique.

- Click the **Add Data** button and add the **eurodata.txt** file from the **ChoroplethData** folder.

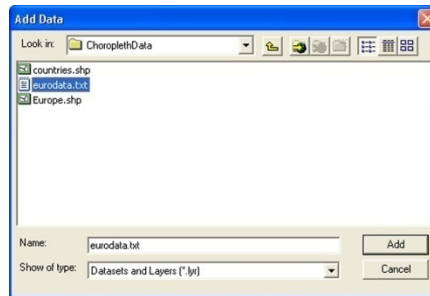


Figure 13. Adding the eurodata.txt file.

The file is added to the Table of Contents. Note that the tab at the bottom of the Table of Contents switched from **Display** to **Source**.

- Right-click the eurodata.txt and select **Open** from the context menu.

Country	AreaKm2	Population	PhonesLine	PhonesCell	IntertelArea	IntertelRate
Albania	28748	3619778	353600	1530000	471200	852
Andorra	468	72413	35400	64600	23200	15406
Austria	83870	8265533	356000	925500	420000	242700
Belarus	207600	9695768	3360000	5960000	5470000	20685
Belgium	30528	10403951	4719000	9660000	4890000	3195000
Bosnia & Herzegovina	51129	4592010	95000	1800000	95000	39627
Bulgaria	110910	7262675	2398000	6253000	1870000	298781
Croatia	56542	4491543	1832000	4470000	1576000	281954
Czech Republic	78869	10220911	2680000	12460000	5641000	1168800
Denmark	44493	5533991	3121000	5891000	3205000	3122490
Estonia	45228	1307905	541900	1659000	760000	387338
Finland	339145	5244749	1020000	5970000	2925000	232300
France	643427	64057790	34630000	63023000	31296000	1256600
Germany	357021	82989548	54200000	84300000	38600000	1648400
Greece	131940	11922016	6195000	11098000	2046000	80624
Hungary	93000	9693916	3350000	9666000	3500000	231900
Iceland	103000	304367	193700	326500	194000	270942
Ireland	70280	4156119	2097000	4690000	1437000	429487
Italy	301230	59145321	25048000	71500000	2895000	4111900
Latvia	64589	2246423	657400	2184000	1071000	234014
Liechtenstein	160	34489	20000	27500	22000	4753
Lithuania	65200	3565295	792400	4718000	1083000	130100
Luxembourg	2586	486006	246700	713800	339000	132090
Macedonia	25333	2061315	496900	1417000	269000	6001
Malta	316	405522	202300	346800	127200	21386
Moldova	33843	4324450	1018000	1359000	727700	112028
Monaco	2	32796	34000	17200	20000	14520
Montenegro	14028	676177	352300	621600	286000	<NA>
Netherlands	41526	16645313	7600000	15934000	14544000	11170000
Norway	385199	4646622	2050000	5041000	4074000	2084000
Poland	312865	38550996	11470000	36740000	11000000	569100
Portugal	92391	10676910	4231000	12226000	3213000	636616

Figure 14. The eurodata file.

The data in this table are area, population, and communications data which come from the CIA World Factbook (<https://www.cia.gov/library/publications/the-world-factbook/>). The two fields that you will use in this exercise are the **Population** and **PhonesCell** fields. Both fields are 2006 data; the Population field is the country's estimated population and PhonesCell field is number of mobile cellular telephone subscribers (data for Albania, Andorra, Italy, Liechtenstein, Monaco, Netherlands, Sweden are for 2005). Note that one person may have more than one mobile cellular subscription.

To incorporate this data into your map, you will need to perform a data **join**. The fields that you will use to perform the join are the CNTRY\_NAME field in the countries layer and the Country field in the eurodata.txt file.

- **Right-click** the **Europe** layer in the Table of Contents and select **Joins and Relates >Join**. The Join Data window will open.



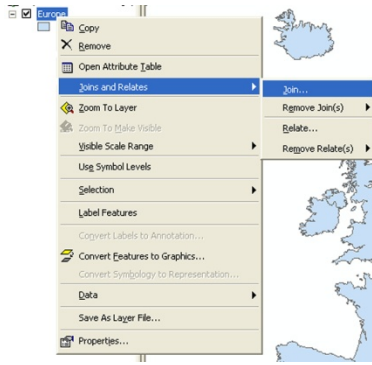


Figure 15. Right-click and select Joins and Relates.

- In the **Choose the field in this layer that the join will be based on** drop-down menu, select **CNTRY\_NAME**. Eurodata.txt and Country should automatically appear in the other two menus. If they do not, select them from the second and third drop-down menus.

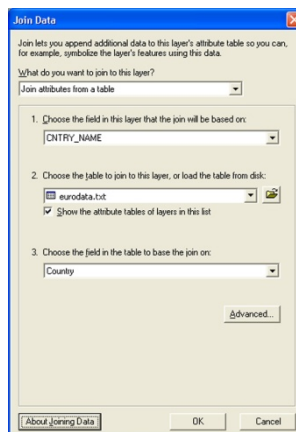


Figure 16. The Join Data window.

- Click **OK** to perform the join and return to the Data View.
- **Right-click** the **Europe** layer in the Table of Contents and select **Open Attribute Table** to see the attribute table with the eurodata fields appended to the end.

Europe/FID	Europe/Shape	Europe/CNTRY_NAME	Europe/Region	Europe/SubRegion	Country	Area(sq)	Population	Phones(fix)	Phones(mob)	Internet	Internet2
0	Poligon	Iceland	Europe	Northern Europe	Iceland	103000	304367	193700	335500	194050	270942
1	Poligon	Ireland	Europe	Northern Europe	Ireland	70200	4156119	209700	4690000	1437000	429487
2	Poligon	United Kingdom	Europe	Northern Europe	United Kingdom	245000	61202393	30796912	69794497	28600200	5123442
3	Poligon	Portugal	Europe	Southern Europe	Portugal	92391	10679910	4231000	12226000	3213000	636616
4	Poligon	Spain	Europe	Southern Europe	Spain	504762	40491051	18386000	46152000	18676000	2952000
5	Poligon	Norway	Europe	Northern Europe	Norway	385199	4546622	2055000	5061000	4074000	2084000
6	Poligon	Sweden	Europe	Northern Europe	Sweden	449664	9045369	6379000	9087000	6961000	3316000
7	Poligon	Andorra	Europe	Southern Europe	Andorra	468	72413	35400	64600	23000	15486
8	Poligon	Morocco	Europe	Western Europe	Morocco	2	32796	34900	17300	20000	14500
9	Poligon	Albania	Europe	Southern Europe	Albania	28748	3616778	353600	1530000	471200	852
10	Poligon	Bosnia & Herzegovina	Europe	Southern Europe	Bosnia & Herzegovina	51129	4590391	869000	1888000	160000	39627
11	Poligon	Croatia	Europe	Southern Europe	Croatia	66541	4493143	1823000	4473000	1576000	261564
12	Poligon	Italy	Europe	Southern Europe	Italy	301230	58145321	26049000	71500000	28650000	4117000
13	Poligon	Macedonia	Europe	Southern Europe	Macedonia	25333	2061315	498600	1417000	260000	6031
14	Poligon	Malta	Europe	Southern Europe	Malta	316	409522	202300	346600	127200	21396
15	Poligon	Vatican City	Europe	Southern Europe	Vatican City	0	624	5120	0	0	0
16	Poligon	Belgium	Europe	Western Europe	Belgium	110943	7262075	3299000	8253000	1870000	266716
17	Poligon	Greece	Europe	Southern Europe	Greece	131940	10722616	6185000	11098000	2640000	905624
18	Poligon	Austria	Europe	Western Europe	Austria	83670	8205633	3564000	9250000	4200000	2427000
19	Poligon	Czech Republic	Europe	Eastern Europe	Czech Republic	78966	10220911	3889000	12460000	3841000	1666000
20	Poligon	Denmark	Europe	Northern Europe	Denmark	44493	5533391	3121000	5891000	3205000	3122490
21	Poligon	Hungary	Europe	Eastern Europe	Hungary	93030	9930915	3200000	9960000	3900000	2313000
22	Poligon	Poland	Europe	Eastern Europe	Poland	312695	38926966	11479000	38746000	11000000	5691000
23	Poligon	Slovakia	Europe	Eastern Europe	Slovakia	49845	5456467	1167000	4893000	2256000	821816
24	Poligon	Slovenia	Europe	Southern Europe	Slovenia	20273	2007711	837000	1620000	1251000	134266
25	Poligon	Romania	Europe	Eastern Europe	Romania	305261	19403951	4719000	8660000	4800000	3166000
26	Poligon	France	Europe	Western Europe	France	643427	64957790	34530000	53023000	31295000	12556000
27	Poligon	Germany	Europe	Western Europe	Germany	357021	8296566	54200000	64000000	38800000	16494000
28	Poligon	Liechtenstein	Europe	Western Europe	Liechtenstein	160	34488	20000	27500	20000	4753
29	Poligon	Luxembourg	Europe	Western Europe	Luxembourg	2696	498006	246700	713000	339000	132000
30	Poligon	Netherlands	Europe	Western Europe	Netherlands	41526	16645313	7050000	15934000	14544000	11170000
31	Poligon	San Marino	Europe	Southern Europe	San Marino	61	29973	21000	17300	15400	3344

Figure 17. The joined attribute table.

- Close the attribute table.

When attribute tables contain more information than you will be working with in your project, it sometimes is a good idea to turn off which fields are displayed.

- To reduce the number of displayed fields to the ones you will work with, open the **properties** for the **Europe layer** (right-click Europe and select Properties from the context menu).
- Select the Fields tab and then deselect all the fields **except** Europe.CNTRY\_NAME, Population, and PhonesCell.

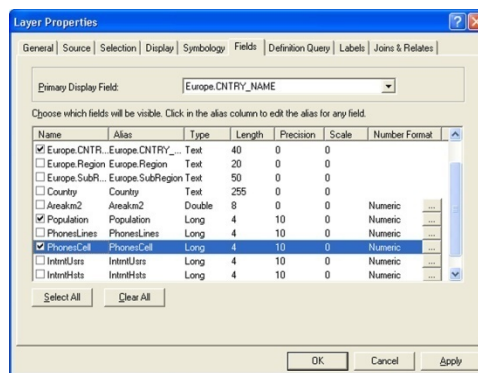


Figure 18. When displaying a small number of fields, click the Clear All button and then select the fields to be displayed.

- Click **OK** to apply your changes and close the Properties window.
- Reopen the Europe attribute table to see the change.

Europe.CNTRY_NAME	Population	PhonesCell
Iceland	304367	326500
Ireland	4156119	4690000
United Kingdom	61205393	68784497
Portugal	10676910	12226500
Spain	40491851	46152500
Norway	4646622	5041000
Sweden	9045389	9067000
Andorra	72413	64600
Norway	32796	17200
Albania	3619776	1530000
Bosnia & Herzegovina	4590310	1886000
Croatia	4491543	4470000
Italy	58145321	71500000
Macedonia	2061315	1417000
Malta	40352	346800
Vatican City	324	4160
Bulgaria	7262675	8250000
Greece	10722816	11086000
Austria	826553	9255000
Czech Republic	10220911	12460000
Denmark	5533391	5891000
Hungary	9330915	9965000
Poland	38500596	36746000
Slovakia	5455407	4990000
Slovenia	2007711	1820000
Belgium	10403951	9660000
France	64657790	62620000
Germany	82366548	84300000
Liechtenstein	34498	27500
Luxembourg	486268	713500
Netherlands	16645313	15834000
San Marino	29873	17390

Figure 19. The attribute table showing only the selected fields.

- Click the **display tab** at the bottom of the Table of Contents so that you can see only your

two map layers in the Table of Contents.

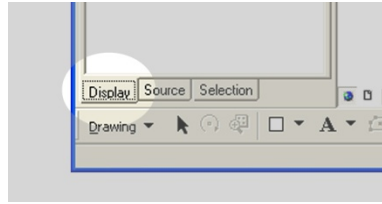


Figure 20. The display tab.

## The Choropleth Map

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- To make a choropleth map using the cell phone data, first open the **properties window** for the **Europe** layer(right-click the layer name and select **Properties** from the context menu).
- Select the **Symbology** tab and then select **Quantities > Graduated colors** from the items in the Show box.
- Select **PhonesCell** from the **Value** drop-down list and click **Apply** to register the change to the map.
- Move the Properties window out of the way so you can view the map.

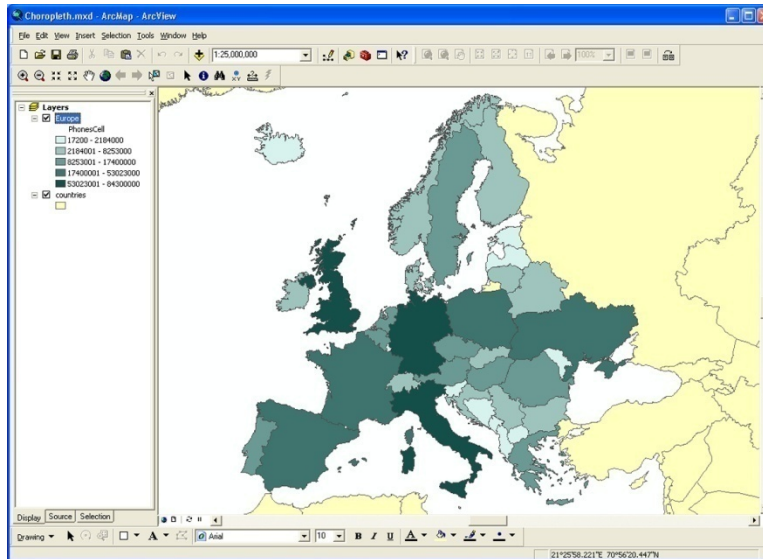


Figure 21. Choropleth map of the number of mobile cellular phones.

At first glance, this map appears meaningful as there is variety in the pattern on the map. Upon further inspection, the map is not terribly effective. A quick check of the attribute table, however reveals that the countries with the most mobile cellular phones are the countries with the largest populations. In essence, the map you just produced is nothing more than a proxy map of population.

As discussed in chapter six of your textbook, totals should not be used in the choropleth technique. Rather, the choropleth should use ratios involving area (i.e., densities) or ratios independent of area. You will use the latter.

- With the Properties window still open, select **Population** from the Normalization drop-down list. Doing so will produce a new value that is created by dividing the Value field (PhonesCell) by the Normalization field (Population).

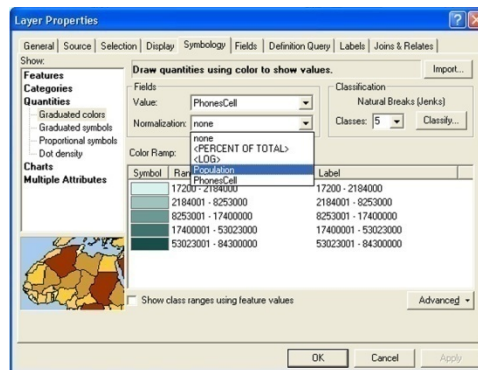


Figure 22. Normalizing your field from within the Symbology tab.

While you now have normalized data for your map, the numbers themselves are not without problems. Because the values of the individual fields were close in size to each other, your resulting normalized values are fairly small—ranging from approximately 0.3 to 1.5. Additionally, the calculation resulted in normalized values with as many as 9 decimal places. In the case of the map you are making, 0.615335821 mobile cell phones per person is not more meaningful than 0.62 mobile cell phones per person.

At present, the derived values are the number of mobile cellular phones per person. You will adjust the legend values to represent them as the number per 100 persons.

- Right-click one of the ranges (it doesn't matter which), and select **Format Labels**.

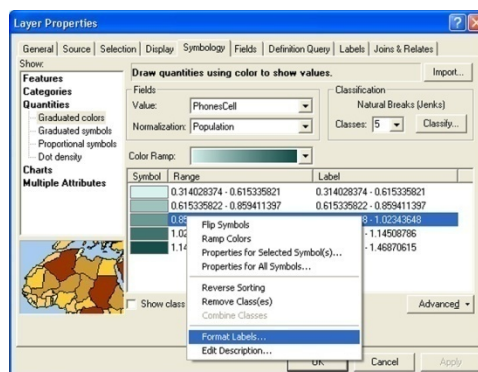


Figure 23. Right-click and select Format Labels.

- In the Number Format window, select **Rate**.

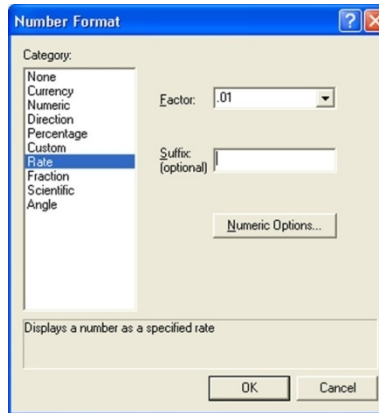


Figure 24. The Number Format window.

Notice **Factor** in the upper right-hand portion of the window. The factor is the numerical adjustment to your legend values. Your values will be *divided* by this amount. For example, a value of 25.75 that is formatted as a rate with factor of 100 will become 0.2575.

In order to convert your values from their current *per person* amount to a *per 100 persons* amount, you will need to **multiply** your values by 100. Because the software *divides* the label values by the factor, you will need to enter a decimal. To multiply by 100, you need to divide by .01. Similarly, dividing by .1 is equivalent to multiplying by 10.

- To multiply by 100, change the Factor to **.01**.
- Before clicking OK, click the **Numeric Options** button. The Numeric Options window opens.
- Making sure the **Number of decimal places** radio button is selected and change the rounding number to **2**.
- Check the **Pad with zeros** checkbox. Doing this will ensure that all legend values have two decimals. For example, 21 will be displayed as 21.00 and 31.4 will be displayed as 31.40. It is advised that you be consistent with the number of decimals in your labels so as to not convey different levels of precision—like having some labels in tenths and others in hundredths.

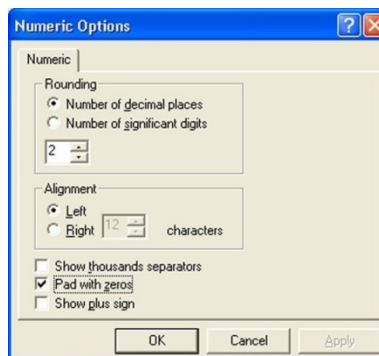


Figure 25. Change the rounding number to two.

- Click **OK** to close the Numeric Options window.
- Click **OK** to close the Number Format window.

Note the revised values in the Label column.

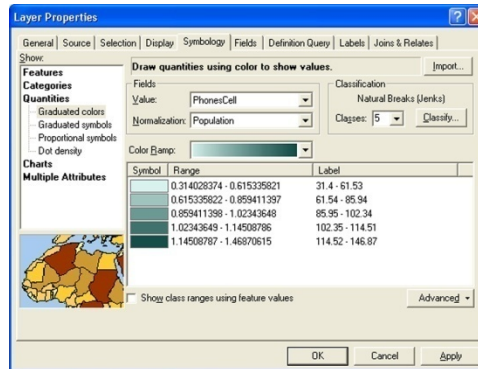


Figure 26. Your labels should now range from 31.4 to 146.87.

The series of colors used to represent the classes is called the **color ramp**. ArcMap has many ramps from which to choose. The default view of the color ramp is the **graphic view**, which displays the range of colors that will be used for symbolization.

- **Click on the color ramp to view the drop-down list.**

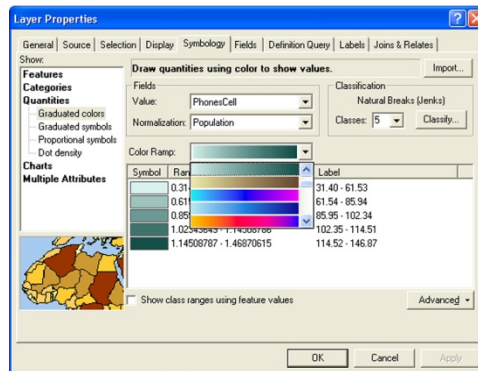


Figure 27. The Color Ramp using the Graphic View.

- Switch the ramp to any of the options. Click **Apply** to register the change on the map. Move the properties window to the side if necessary to view the changes on the map (do not close the window yet).

You may also view the color ramp by name.

- **Right-click** the color ramp and deselect Graphic View from the context menu.

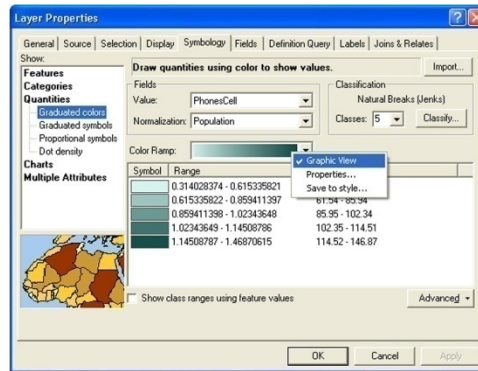


Figure 28. Turning off the graphic view of the color ramp.

- Again, **click on the color ramp** to view the drop-down list.
- Choose the **Blue-Green Light to Dark** ramp. Click **Apply** to register the changes in your map.

**i** In addition to the predefined color ramps, you can also adjust the properties of individual class symbols. To do this, either double-click the symbol you wish to change or right-click on it and select **Properties for Selected Symbol(s)**. The Symbol Selector window will open allowing you to change the symbol properties. For an excellent online tool to select additional color schemes for choropleth maps, refer to the ColorBrewer website (<http://colorbrewer.org>).

- Click **OK** to apply the changes and close the Properties window.

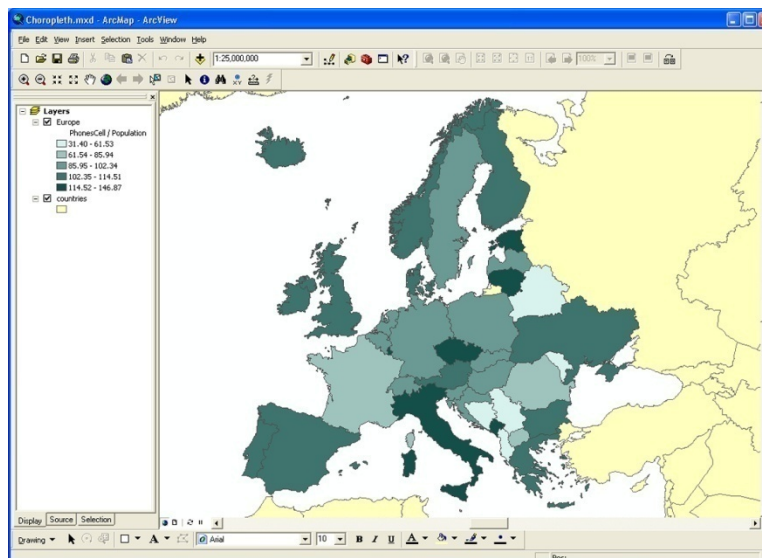


Figure 29. The normalized choropleth map.

Compare this map to that in Figure 21 and notice that by normalizing the data, you are able to see that some countries with relatively small populations (e.g., Latvia, Luxembourg and Czech Republic) have a relatively high *proportionate* use of mobile cellular phones.

If you are unfamiliar with the countries of Europe, label the countries by **right-clicking** the Europe layer and selecting **Label Features** from the context menu. Turn off the labels by repeating the process before continuing.

## Classification

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An important consideration in the choropleth technique is that of classification. ArcMap allows you to choose between several classification techniques as well as specify the number of classes you will use.

- To see how to change classification techniques, re-open the Properties window for the Europe layer (right-click the layer name and select **Properties** from the context menu).
- If it is not already the active tab, click the **Symbology** tab.

In the upper right-hand portion of the Symbology tab is the **Classification** box. This area displays the current classification method, the number of classes, and contains the **Classify** button.

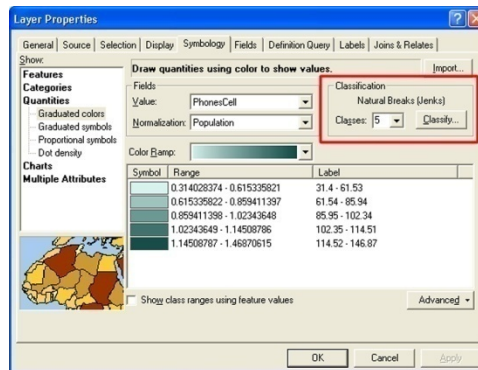


Figure 30. The Classification box.

- **Click** the **Classify** button. The Classification window opens.

The Classification window displays several items:

1. The Classification items, which allow you to set the classification method and number of classes;
2. The Data Exclusion items, which allow you to exclude data from the classification scheme as well as base your classification on a sample;
3. The Classification Statistics box, which shows the descriptive statistics for the values being classified;
4. The Break Values box, which shows the upper limit of each of the classes; and



- A histogram of the data which includes lines showing the upper limit of each class. You can change the number of columns in the histogram and also display the mean and standard deviation values.

**i** A histogram is a graphical portrayal of a frequency distribution. To create the frequency distribution, the values are arranged in classes, or *bins* (similar to the classification that you are doing for this map). The vertical bars of the histogram represent the *number of occurrences* in each of the bins.

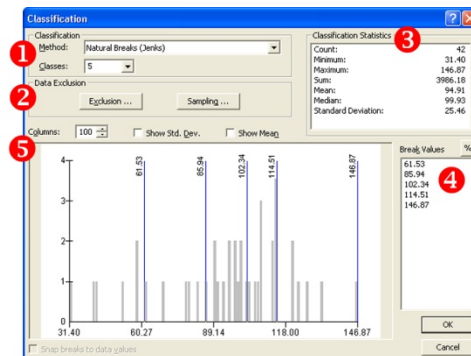


Figure 31. The Classification window.

- To better see the distribution of the data, change the **number of columns** from 100 to **20**.

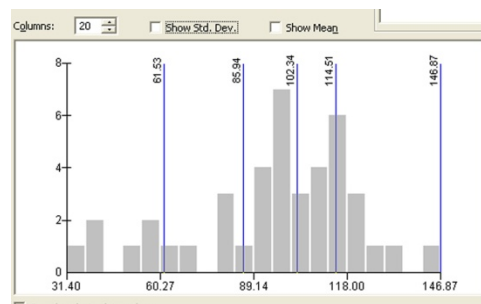


Figure 32. The histogram with 20 columns.

- Click the **Method** drop-down list. There are six automatically-calculated classification schemes—Equal Interval, Defined Interval, Quantile, Natural Breaks (Jenks), Geometrical Interval, and Standard Deviation—and Manual, which allows you to define your own class ranges.

While many classification methods are available for you to use, you will explore three here. Refer to Chapters Five and Six of the textbook for detailed discussion of the various classification schemes.

As noted in your textbook, historically, two of the most popular schemes have been equal interval and quantiles. The equal interval classification method divides the data range into equally-sized classes. In the quantile classification method, each class will contain the same number of observations.

- From the **Method** drop-down list, select **Quantiles**. Keep the number of classes at **5**. Click **OK** to register the change and close the Classification window.
- Click **Apply** to register the change to the map. Move the Properties window out of the way so you can view the map.

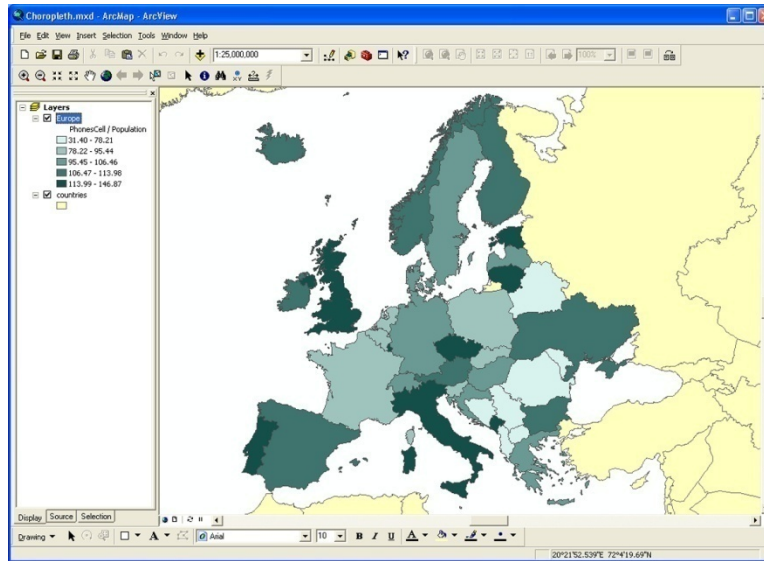


Figure 33. The quantiles classification.

In the quantiles classification, the same number of observations are found in each class. It is best suited for data that are uniformly (linearly) distributed. As observed in the histogram (Figure 32), the mobile cellular phone data are not linearly distributed.

Now you will view the map using equal interval classification.

- **Click** the **Classify** button to reopen the **Classification** window.
- From the **Method** drop-down list, select **Equal Interval**. Keep the number of classes at **5**. Click **OK** to register the change and close the Classification window.
- Click **Apply** to register the change to the map. Move the Properties window out of the way so you can view the map.

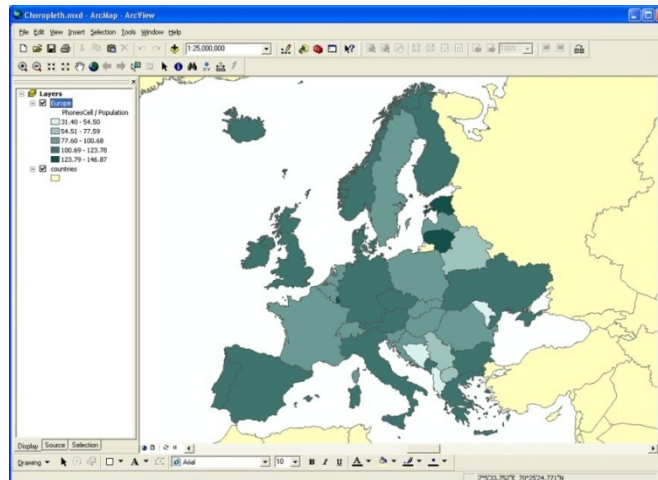


Figure 34. Equal Interval classification.

Note that the number of observations in each class varies: most of the countries are in the third-highest and fourth-highest classes. This scheme is especially effective as the uniformity of class size is easily understood by most map readers. It is often used when mapping percentages.

The third classification scheme to explore is Natural Breaks (Jenks). This method uses a mathematical procedure (optimization) to define natural groupings of observations. The ultimate goal of this method is to group together similar observations and separating observations that are dissimilar. Natural Breaks has become increasingly popular in recent years and is the default classification method for ArcMap.

- Click the **Classify** button to reopen the **Classification** window.
- From the **Method** drop-down list, select **Natural Breaks (Jenks)**. Keep the number of classes at **5**. Click **OK** to register the change and close the Classification window.
- Click **OK** to register the change to the map and close the Properties window.

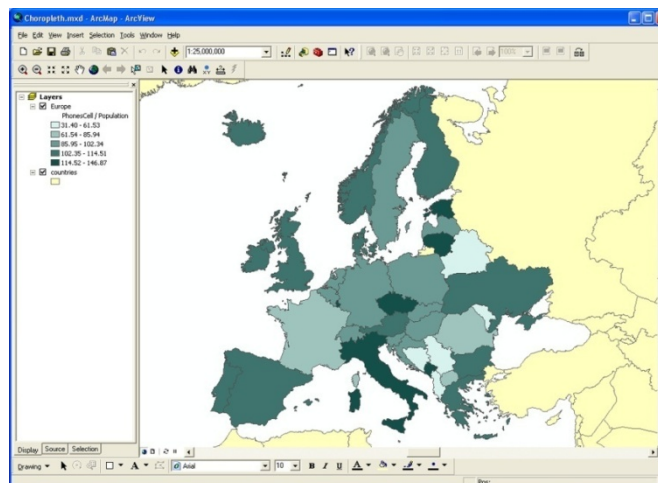


Figure 35. The Natural Breaks (Jenks) classification.



It is customary when using the natural breaks classification method to use a noncontinuous style for class ranges. In the continuous style, there are no gaps in the class ranges. The smallest value in a class is one unit (tenths, hundredths, etc.) larger than the largest value of the previous class. In the noncontinuous style, the ranges are defined by both the smallest and largest value in the class, not by continuing from the previous class. By using the continuous style for natural breaks classification, the classes are artificially expanded. By using noncontinuous style, gaps are introduced between classes. The default in ArcMap is to use the continuous style. To use the noncontinuous style, you must manually change the label of each class to reflect the *actual* smallest value of the class (the largest value is correct). This is done by referring to the attribute table. When doing on-the-fly normalization, you do not have values in tabular form to reference. To determine normalized values for the individual observations, you must either create a new field and use the Field Calculator tool (not covered in this exercise) or calculate the values outside of ArcMap (using a spreadsheet, for example). Refer to Chapter 6 of the textbook for a discussion of using continuous or noncontinuous class ranges.



When making maps using the choropleth technique, it is important to have a good understanding of the different techniques and the appropriateness of a technique for *your data*. Your choice of classification method should be data-driven, not what is simplest to produce.

## Creating the Layout

- Switch to the **Layout View (View >Layout View)**.
- Using the **Page and Print Setup** menu item (right-click outside the page in the layout view to get the context menu where this is located), **change the Orientation to Landscape**. Also make sure the **Use Printer Paper Settings** and **Show Printer Margins on Layout** boxes are checked.

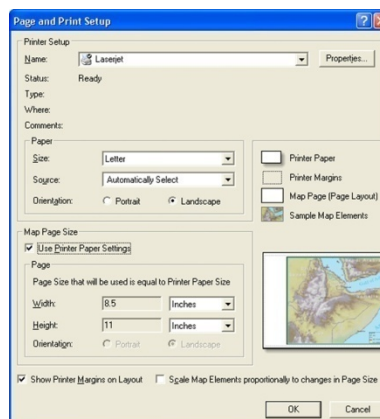


Figure 36. Page and Print Setup.

- Click **OK** to register your changes and close the window.

When you changed the orientation of the page from portrait to landscape, your data frame did not resize. You will need to resize the data frame to fit in the layout. Resizing is accomplished in one of two ways: clicking and dragging one of the sizing handles (boxes that appear along the edge of the data frame when the data frame is selected) or adjusting the size of the frame in the Data Frame Properties window. You will do the latter.

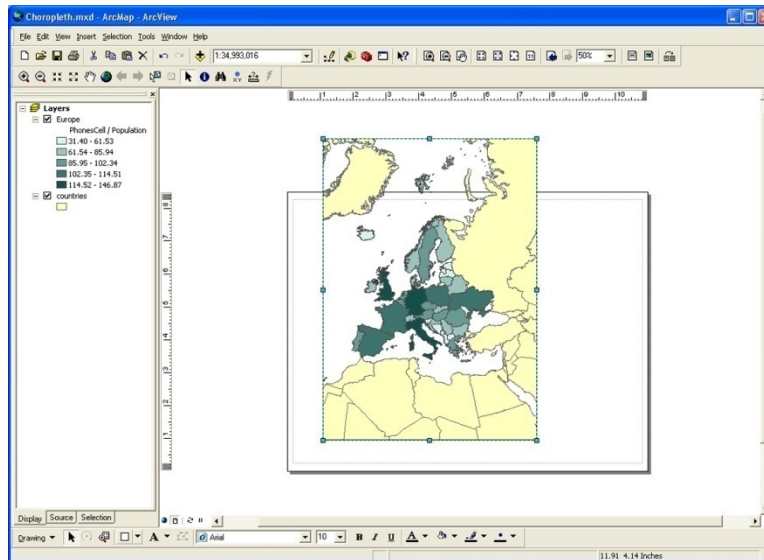


Figure 37. Your data frame no longer fits the layout following the switch to landscape orientation.

- **Right-click** the **data frame** (mapped area) and select **Properties**.
- Click the **Size and Position** tab.
- Change **both** the **width** and **height** to **7.5 in**.

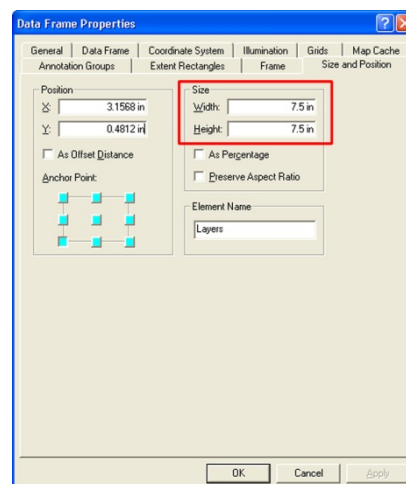


Figure 38. Setting the dimensions of the data frame.

By resizing the data frame, the scale of the map may have changed—it is common for you to be at a smaller scale than you were in the data view following the resizing.

- Make no other changes to the data frame and click OK to close the Properties dialog.
- If necessary, zoom back in to the European countries using the **Zoom In** tool on the **Tools** toolbar. Be sure you are not using the Zoom In button on the Layout toolbar.



Figure 39. Tools toolbar *Zoom In* button.

- Click OK to register your changes and close the Properties window.
- Insert a **neatline** (**Insert >Neatline**). Make it **2 points** thick and place it inside the print margins with a **5 point** gap.

You may need to reposition your data frame to be inside the neatline.

- Add the **map title** (**Insert >Title**). Map titles for thematic maps generally have one or more of the following items: (1) the subject matter of the map, (2) the location being mapped, and the (3) year or time period of the subject matter. Those three elements for this map are (1) mobile cellular telephones, (2) Europe, and (3) 2006. Word your title appropriately given these three elements.
- Place the map title in the top of the space to the left of the mapped.

Next you will add the map legend.

- Select **Insert >Legend**. The Legend Wizard window appears.
- You want only the **Europe** layer to be in the legend. To remove the countries layer, select it and click the single left-pointing arrowhead.
- Click **Next** to go to the Legend Title window. **Change** the Legend Title to **Subscriptions per 100 Persons**. In thematic mapping, legends commonly have the *units* of the subject matter.
- Click **Next** through the remaining items, and click the **Finish** button to close the wizard and return to the layout. If necessary, move the legend into the blank space in the lower half of the layout to the left of the mapped area.

You may notice that the legend title is a little wider than the available space and that there are a few extra text items in your legend that you do not need: Europe and PhonesCell/Population. You will adjust the title and remove the extra items, but first you will need to convert the legend to individual graphics items to do so.

- Convert the legend to graphics by right-clicking it and selecting **Convert to Graphics**.

There will not appear to be any change to the legend, but it is now a **group** of individual graphics. To make changes to the legend items, you will need to **ungroup** these items.

- **Ungroup** the legend. To do this, select the legend (it may already be selected) and, using the Drawing button on the Draw toolbar, select Ungroup. The Draw toolbar is at the bottom of the ArcMap window by default. If you do not see the Draw toolbar, right click a toolbar and select Draw from the context window. (You may also right-click the items and select **Ungroup**).
- Click anywhere outside the layout to deselect the graphics.
- **Click on Europe and PhonesCell/Population and delete** them (use the Delete key on your keyboard).
- Next, **double-click** the legend title to open the text Properties window.
- Move **100 Persons** to a new line by clicking before 100 and pressing the Enter key on your keyboard.
- Center-align the text by clicking the center-align button.

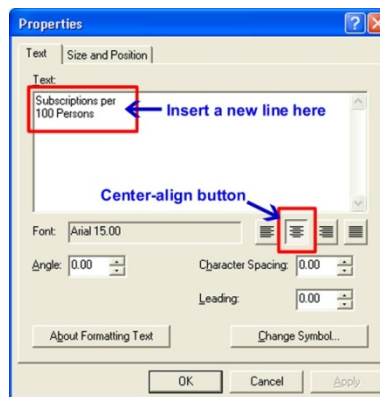


Figure 40. The text properties window.

- Reposition the legend title so it is immediately above the legend items.
- Next, **select the legend title and the other legend elements**. You may either hold down the shift key and click on the individual items or click-and-drag a box around the items—be careful not to select the mapped area or neatline when you do this.
- With these items selected, **group** them. Using the **Drawing button** on the **Draw toolbar**, select **Group**.

- Beneath the legend, add the following text (three lines, 8 point font, left-aligned):  
Data for Albania, Andorra, Italy,  
Liechtenstein, Monaco, Netherlands,  
Sweden are from 2005
- In the lower left-hand corner of the page, add the cartographer information (two lines, left-aligned):  
Your name  
Today's date

To print a hard-copy of the map:

- Click on the **print button** or select **File >Print** (you may also print preview using **File >Print Preview**)

To create a PDF document (for digital submissions):

- Export the map by selecting **File >Export Map...**
- Change the **Save as type:** to **PDF (\*.pdf)**.
- The Resolution should be **300 dpi** and the **Output Image Quality** should be **best**. Keep these settings unless directed otherwise.



## Exercise Questions

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1. How do the conventional choropleth technique and the unclassed choropleth technique differ?
2. When employing the conventional choropleth technique, approximately how many classes should you use?
3. If you had a shapefile consisting of states of the United States, how would you create a new shapefile of only the New England states?
4. If your attribute table contained two fields, *Population* and *Area* (in square miles), how would you create a choropleth map of the derived value of Population Density (persons per square mile)?
5. What are the classification schemes available in ArcMap?
6. When symbolizing your areas, how can you view the *names* of the available color ramps?
7. How can you automatically round the legend values to two decimal places?
8. How can you view descriptive statistics and a histogram of your data from within the Symbology tab of the Layer Properties window?
9. How do you resize your data frame to *specific dimensions* in the layout?

10. In choropleth mapping, and thematic mapping in general, what is commonly used as the legend title?