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Rocky Mountain Mapping Center

Exploring A Century of Population Change Across the United States with GIS: Answer Key

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Overview: In this lesson, you will have the opportunity to examine 100 years of population change by county across the United States.

GIS Skills:
1) Data management.
2) Joining, summarizing, querying, and sorting data.
3) Creating and populating new fields in a database.
4) Creating graphs and pie chart maps.
5) 3D analysis.

Data Management

Create a folder on your computer where you will store the data.

Click **here to download the data** that you will need for this lab exercise.

This file is named popchangeusalesson.zip and totals approximately 1.4 MB.

After downloading, unzip the file using the Winzip program.

You now should have the following **6** files:

co1900_2000.dbf
county20thcentury.dbf
county20thcentury.sbn
county20thcentury.sbx
county20thcentury.shp
county20thcentury.shx

Using Windows Explorer, answer the following questions:

1) Which file of the above is the largest? Why do you suppose that is the case?

[The county20thcentury.shp is the largest file. The geometry for all the counties in the US are listed in the file.]

Exploring the Data

Access ArcView GIS.

Begin a new project with a new view.

Add data to the view: county20thcentury

Make the themes visible by checking on the box to the left of the theme name.

2) What *extent* of geography does the county20thcentury.shp file cover?

[**All the USA is covered by the map.]**

3) What *level* of geography does the county20thcentury.shp file cover?

[**Contains demographic information by county in the USA.]**

Open the theme table for county20thcentury. Access the "open theme table" tool  or go to Theme-->Table.

4) How many records are in this table?

[3,140]

5) How many county polygons are in the data set?

[**One polygon for each county - 3,140]**

Go back to the map. Click on the Identify button (far left on the button bar) and click on one of the polygons.

The data are mostly from the 1990 census. Remember that these are self-reported values--how people listed themselves--on the census forms.

6) Briefly describe the types of data that can you can analyze in this file:

[**Demographic information about each county. Population, gender, race, Farm acreage.]**

Note the coordinates in the upper right as you move around the view with your mouse.

7) What coordinate system is the data in?

[Geographic - latitude / longitude]

Save the project:

File-->Save Project As - and name it "county20thcentury.apr" in your folder.

Data Analysis

Make View1 active.

Go to the View--> Properties pull-down menu.

Change the name of View1 to “USA Counties”

Access the table behind the theme county20thcentury.

Click on the field “Pop1990.” Access the menu: Field-->Statistics.

8) What was the total United States population in 1990, according to this database?

[**248,709,873]**

Click on the field “Ameri_es.” This is the population for American Indian and Alaska Natives in 1990. Go to Field-->Statistics.

9) What was the Native American population in 1990, according to this database?

[**1,959,234]**

Use the "sort descending" button in the button bar  to answer the following question.

10) In which county and state did more Native Americans live than any other in 1990? Why?

[**Apache, Arizona. The Navajo Nation covers this entire county.]**

11) What was the #2 most populous county in terms of Native Americans in 1990? Why?

[Los Angeles, California. Los Angeles County contains over 8 million people, including a great many people from many different backgrounds, including Native Americans, Asian Americans, African Americans, Hispanic Americans, and others.]

12) Either by sorting the table, or by using the query tool, answer the following question: How many counties reported no (0) Native Americans in 1990?

[17]

13) By using the query tool or the "find" button (looks like a binoculars), answer the following question: What was the Native American population in Todd County, South Dakota, in 1990?

[6,883. Notice that there is more than one county named Todd in the United States.]

Click on this record in the table.

On the map, zoom to this county using the "zoom to selection" button. 

Clear the selection by clicking on the button that looks like a blank piece of notebook paper.

Zoom to the full extent of all themes by clicking on the tool that looks like an arrow pointing into a stack of layers.

Access the legend editor by double-clicking on the theme name “county20thcentury.shp” in the view.

Change the legend type from “single symbol” to “graduated color.” Access the pull-down menu.

Change the classification field to “ameri_es". Apply.

14) What happened in your view?

[Now you are classifying the Counties of the US to show where Native American Indians lived in 1990.]

15) The default classification that you just created is “natural breaks” with 5 categories. The software looks at the range of data, and decides where to place the break points. Is this type of legend helpful for analyzing Native American population? Why or why not?

[Not really, because most of the counties are in the lowest category.]

Access the legend editor again. Under "classify" (right hand side), experiment with the other 4 classification methods: standard deviation, quantile, equal area, and equal interval.

16) In your opinion, which method was the best classification method to use for analyzing the Native American population by county?

[Answers may vary. Quantile may give the best impression...]

Why?

[... because quantile contains the same number of counties in every class.]

17) In a few sentences, describe the pattern of population distribution of Native Americans in the USA by county in 1990.

[Native Americans can be found in most counties in the USA. The highest concentrations are in Oklahoma, the Great Plains, Arizona, and in urban areas.]

Access the legend editor by double-clicking on the theme name “county20thcentury.shp” in the view.

Change the field that you are mapping and make a map of Hispanic American Population for 1990.

18) Make two observations about the spatial pattern of Hispanic Americans on the map you just created.

[The Hispanic population is more concentrated than Native Americans; concentrated in the Southwest USA counties, but also in urban areas, in the northeast, Florida, and so on.]

Change the field that you are mapping and make a map of African American Population for 1990.

19) Make two observations about the spatial pattern of African Americans on the map you just created.

[African Americans are in most counties, particularly in urban areas, the South, Midwest, Northeast, and Southern California.]

Change the legend back to mapping Native Americans.

Click on the query builder (hammer with question mark). 

You are interested in managing a program out of your Rosebud Sioux Tribal Land Office in Rosebud, South Dakota, for Native Americans across the country. For your program, you need to find counties with over 5,000 Native Americans.

20) What expression do you need to create to find these counties? Indicate it below:

[Use the Query Builder to create the following expression ([Ameri_es] >5000)]

Use your expression and select “new set.”

21) What happened to your map?

[Those counties with a Native American population > 5000 are highlighted.]

Access the table. 

22) How many counties in your selection have over 5,000 Native Americans?

[82]

23) Promote these records to the top  . How many of these counties are in South Dakota?

[Either, in the table, promote to bring all the selected items to the top for a manual review; or run a new query:

([Ameri_es] >5000) and ([state_name] = "South Dakota") Answer = 3.]

24) What are the names of the counties in South Dakota with over 5,000 Native Americans in 1990?

[Pennington, Shannon, and Todd]

Accessing Additional Data Through Tabular Join

In spatial analysis with GIS, sometimes you may want to access additional information that is not part of the original database. One way to access this information is to join additional tables to your original database. You did this in previous lessons, and you will have another opportunity to do it here.

Make your view active. Clear your selection with the blank piece of notebook paper tool. 

Make your county20thcentury.apr (the project window) active by clicking on it. If you have maximized all windows, go to the Window pull-down menu and select county20thcentury.apr.

On the left side of the project window, go to “tables” and select “add”.

Navigate to your folder where your data is stored.

Add the table "co1900_2000.dbf"

Open your co1900_2000.dbf table.

25) How many records are in this table?

[3,140]

26) Is this more, less, or the same number of records as the attributes of county20thcentury table?

[The same]

27) What kind of data is found in the co1900_2000.dbf table?

[Total population from 1900 to 2000, every decade.]

Open your “attributes of county20th Century” table.

Note the field that contains FIPS (Federal Information Processing Standard) codes for counties.

You are now ready to join the 2 tables. It is **very important** to do the join in the correct order. You want to join FROM the table you just added (co1900_2000.dbf) TO the table associated with the map (attributes of county20thcentury table). Be careful not to click inside the table and inadvertently select any records in the table. If you did this, you’d only join these selected records, rather than the entire table.

First, click on the FIPS code field in the table "co1900_2000.dbf."

Second, click on the FIPS code field in the table "Attributes of county20thcentury."

Third, click on the “Join Tables” button. (looks like 2 tables with an arrow joining them) 

Now, examine your attributes of county20thcentury table.

28) What happened to the original width of the table in terms of its size?

[More columns are added at the end.]

Double-click the county20thcentury shape file to access the legend editor.

Access the “classification field” pull-down menu.

29) What has happened to the number of fields you can now map?

[**Increased]**

Your tables are joined, but not permanently. Make it a permanent join as follows:

* Make sure you clear any selections first! * 

Then: Theme --> Convert to shapefile.

Name the shapefile “countyall.shp” and place it in your folder containing your other data for this project.

Add the new shapefile into your view.

30) Does this new shapefile have the same number of records and fields as the one you have just been working with? Why or why not?

[Yes - same number of records because the new shapefile was created from the old file with the join.]

Make county20thcentury the active theme by single-clicking on it.

Now, delete the county20thcentury theme. Edit-->Delete theme.

31) Why are you safe in deleting this theme?

[**All the data was saved in the new shapefile just created.]**

1900 Analysis

Change the legend and make a map of 1900 county population.

Access the table. Use field statistics.

32) What was the USA population as indicated by the sum of all the county populations in 1900? Use Field Statistics after clicking on the 1900 population field.

[75,541,434]

Sort by 1900 county population. 

33) What was the county with the highest population in 1900?

[**New York, New York]**

On the map, use the "zoom to selected" button to zoom to that county. Use the label tool to label the county and those around it.

34) Why was this county's population so high in 1900? Anchor your answer to a discussion of immigration to the USA in 1900 and the point of arrival for most immigrants.

[**Many immigrants were arriving from Europe, entering the USA through New York Harbor at Ellis Island.]**

Analyze how this county has changed in population from 1900 to 2000 by creating a graph of its population. In the project window, go to Charts--> New. Give your chart a title, and, one by one, add the following fields to the chart: P1900, P1910, P1920, P1930, P1940, P1950, P1960, P1970, P1980, P1990, and P2000.

35) Print your graph and answer the following questions: How has this county changed in population over the past century? Why did the population decrease from the early until the latter part of the 20th Century? Why did the county start increasing in population? Anchor your discussion in internal migration, metropolitan suburbanization, changes in employment and economy, and gentrification.

[New York county's largest increase in population was in 1910 as immigrants from Europe entered the USA at New York. People started to migrate from New York to other parts of the country in the 1920's. The Great Depression started in 1929 took a toll on the number of jobs in New York. People migrated to other areas to find work. At the same time fewer and fewer immigrants were entering the US as a result of WWII. The slight increase in the 1950s was a result of the Baby Boom generation being born. Fewer immigrants were coming to the US from Europe. The 1960's through 2000 saw people moving from the cities to the surrounding suburbs or moving to other areas of the country. Many New Yorkers moved to the warmer Sun Belt states as they moved into their retirement years. After 1980, some gentrification and a back-to-the central city movement in many cities, including New York, brought some population increases.]

36) Select two other center-city metropolitan counties such as Harris County, Texas, St Louis County, Missouri, and Wayne County, Michigan, make a graph of their population changes, and compare the growth of these counties compared to the county you examined in question 33.

[Wayne County Michigan is where the City of Detroit is located. Detroit is the Motor City of the World, home to the American automobile industry. As the manufacturing of cars in creased in the 1920s, so did the counties population. This growth continued in the 40's, 50's, 60's, 70's, and 80's. The population of Wayne county started to decline as people moved from the county to the surrounding counties away from the city of Detroit. Starting in the 1980's the American automobile companies lost market share to foreign manufactures which resulted in the closing of many plants. Wayne County has not seen the increases common in other cities after 1980 with the return of people to the central city.]

Analyzing 20th Century Change

Clear your selection  and use the procedures you learned above to answer the following questions:

37) What USA county had the largest population in 1950?

[**Cook County, Illinois]**

38) What USA county had the largest population in 2000?

[**Los Angeles, California]**

39) Describe the direction of population change from 1900 to 2000 across the United States as evidenced by the county with the largest population in 1900 vs 1950 vs 2000. Why did the population move the way it did?

[The population of the US spread from the East cost to the West coast. When people first immigrated to the USA, they first stayed in New York. As more jobs became available they moved to the Midwest. California attracted growth because of the growth of technology in the state and its warm climate.]

40) Make a graph and describe how the population of Todd County, South Dakota has changed from 1900 to 2000. What influence do you think do Native Americans have on the historical and current population of the county? Why?

[Todd County grew over the years, but not as rapidly as other counties, due to its rural nature. Native Americans (because of their larger families, university, and tribal government, providing some job opportunities, have ensured that the county did not decline in population as other counties have done in the region.]

Access the table  . Use the field-->summarize tool to answer the following question:

41) What was the USA population as indicated by the sum of all the county populations in 1950?

[150,903,212]

42) What was the USA population as indicated by the sum of all the county populations in 2000?

[281,415,622]

Even though the population of the entire country increased, not every county necessarily increased. Use the query tool  to find out which counties had more people in 1900 than they did in 2000:

Use the following formula: ([P1900] > [P2000])

43) How many counties were selected?

[688]

44) Do these represent counties that are growing or counties that are declining?

[Declining]

45) How many of these counties are in South Dakota?

[28]

46) Describe the pattern of the counties that decreased in population over those 100 years:

[**Most of the counties that declined are rural, although some central cities are also included. Most are agricultural, although some mining counties are included. The pattern is focused on the Great Plains, and in particular, the Upper Midwest.]**

47) Indicate at least two reasons why the counties have decreased in populations according to the pattern you identified above.

[**People have left these areas because of lack of jobs. People have left these areas for warmer climates. People have moved from the farms or mining to service jobs, manufacturing jobs, or to centers of technology.]**

Clear the selected set. 

Using the above procedures, do the same thing for 1990 versus 2000 counties.

48) How many counties had more residents in 1990 than they did in 2000 ?

[683]

49) How many of these counties are in South Dakota? Compare this to the number you indicated above that lost population over the previous 100 years.

[32 are in South Dakota. More counties continue to lose population than gain, because the state is predominately rural. The urban counties are gaining, as well as most Black Hills area counties; the state as a whole is gaining.]

50) Compare the number of 1990 vs 2000 decreasing counties to your 1900 vs 2000 number above, and compare the spatial pattern of each set. Indicate two similarities and two differences between the 10 year pattern and the 100 year pattern.

[**To perform this analysis, you may want to duplicate the countyall.shp file and run the query shown in question 43. Similarities - Again the plain states saw population loss. Counties continue to gain and lose population over time. Differences - More counties in New England are showing loss. The loss of population in the Upper Great Plains states has increased. The number of counties showing loss is moving further West.]**

51) Describe at least two characteristics of the pattern of county population that you believe will exist in the USA in 2100, and give at least two reasons for your prediction.

[The loss of population in counties will continue to move westward. As the Baby Boom generation ages, warmer counties will lose population. As the country also ages, more Midwest counties will lose population.]

52) Clear selection and create a United States map of the change (the second to last field in the table) in population from 1990 to 2000. Make at least two observations of the resulting pattern.

[This is raw number change. The counties with the most change are located in the states of Florida, California and Arizona, but other states also appear.]

53) In the table, sort by the population change. Which three counties gained the most population from 1990 to 2000?

[Maricopa, Arizona Los Angeles, California Clark Nevada]

54) In which states were they? Do the results surprise you?

[**Arizona, California, and Nevada. These are the warm weather states; people move here from the East and Midwest states.]**

55) In the table, sort by the population change. Which three counties *lost* the most population from 1990 to 2000?

[Baltimore City, Maryland Philadelphia, Pennsylvania Allegheny, Pennsylvania]

56) In which states were they? Do the results surprise you?

[**Maryland and Pennsylvania. These areas have lost manufacturing jobs so people have moved elsewhere.]**

57) Clear selection and create a United States map of the percent change (the ***last*** field in the table--percent) in population from 1990 to 2000. Make at least two observations of the resulting pattern.

[**The Great Plains states show the highest percentage of negative change. The Western states of Nevada, Utah, Arizona, and Colorado show some of the highest rates of positive change. The Southern States show moderate rates of positive change.]**

58) Compare the percent change map to the raw population change map and make at least two observations of the differences and similarities between numeric change and percentage change.

[**They both show that the states with the greatest amount of change are in the Western States of California, Nevada, Colorado and Arizona. The Great Plains states show slow rates of positive and negative change.]**

59) In the table, sort by the percent change. Which three counties gained the most in percent from 1990 to 2000?

[Douglas, CO Forsyth, GA Elbert, CO]

60) In which states were they? Do the results surprise you?

[**Colorado and Georgia. Answers will vary. Not surprising - natural amenities in Colorado, suburban expansion along Colorado Front Range and in suburban Atlanta.]**

61) In the table, sort by the percent change. Which three counties *lost* the most population in percent from 1990 to 2000?

[Aleutians West, AK Loving, TX Esmeralda, NV]

62) In which states were they? Do the results surprise you?

[Answers will vary. Loss of military or fishing jobs in Alaska. Mining job loss in Nevada. Rural population loss in Texas, coupled with the very low overall population of Loving County to begin with.]

Creating New Data: Dust Bowl Analysis

Thus far, you have been working with existing data. A GIS also allows you to create *new* data and analyze it. You are working for the US Natural Resources Conservation Service, and wish to examine the population change from 1930 to 1940, focusing on the Dust Bowl period when many people left farms across the Midwest during a series of dry years.

Go to Table--> Start Editing.

Go to Edit--> Add Field.

Make your new field named p30vs40, a number, with 16 width and 2 decimal places.

63) Select the calculate button and calculate the values in your new field. What expression should you use to obtain a percentage change from 1930 to 1940?

[((1940 - 1930) / 1930) * 100)]

Select Table--> Stop Editing and save your edits.

64) Make a graduated color map of your new field and make two observations about the pattern of population change across the country during the 1930s.

[The Great Plains states showed a decrease in population with the Western states picking up population, particularly California, as many Midwesterners moved there to find work. The Midwest states showed heavy losses due to farm depopulation; the Southern states showed some growth.]

65) Based on your observations, which state would you say that most of the displaced farmers from the Midwest moved to during the 1930s? If time permits, read sections of *The Grapes of Wrath* by John Steinbeck.

[Most headed west, to California, and some to the Southern states.]

South Dakota

Next, you want to focus on South Dakota counties. Clear any selections  and use the query builder to select only counties in South Dakota.

66) What expression did you use to select South Dakota counties?

[([state_name] = "South Dakota")]

67) How many counties are selected?

[66]

Use Theme--> Convert to shapefile to save your South Dakota counties into its own data set. Name it sdcounty.shp and place it in your folder.

68) Access the table for your new theme. How many records are in its table?

[66]

69) Why?

[Because you created a new shapefile based on your original selected counties.]

Change the legend for South Dakota counties to a CHART legend type. Your goal is to create a pie chart in each county that indicates the relative percentage of Native Americans in each county. Add the fields pop1990 and Ameri_es to the right side of the box, to create a pie chart of Native Americans and total population in each county. Under "properties," change the size field to Pop1990 and Apply.

70) Describe what happened.

[The circles changed in size to show the counties where the largest populations are located. Inside each circle a slice was made to show of the percentage of the county population that is Native American.]

71) Does the chart map aid your understanding of Native American and Total Population distribution in South Dakota? Why or why not?

[Yes, the charts show the pattern of American Native populations in South Dakota.]

Experiment with the colors, sizes, and with other data in the chart map legend.

Go to View--> Layout and make a layout of your map. Print the layout.

Clear selections.

Save your project.

Three Dimensional Analysis

Three dimensional analysis can aid in understanding many types of geographic phenomena.

If you have the 3D Analyst extension, complete the following section to analyze county population change in three dimensions. If you do not have the extension, skip to the second last question of this lesson.

Go to File-->Extensions, and turn on the 3D Analyst extension. Next, in the project window, click on 3D Scene, and select New.

Add your countyall.shp data to the 3D scene. Make a graduated color map of the field "percent." Make the breaking point between the first and second categories a zero (0) by clicking in the legend itself and typing the new value. Be sure to end category 1 at zero, and begin category 2 at zero. In other words, the first category will represent the decreasing counties, and categories 2 through 5 will represent increasing counties.

Next, go to 3D Scene --> Properties, and change the background color from black to white.

Next, go to Theme--> 3D Properties. **Extrude features** by the following expression: [Percent] / 7

Apply and rotate and zoom around your 3D map of population change from 1990 to 2000.

72) Make two observations of the pattern of population change in the southwest USA--Arizona, Nevada, and California.

[Answers will vary. The change is greatest in southern Nevada and Arizona, but some counties are stagnant or even decreasing.]

73) Rotate the map so that you are looking south from Canada into North Dakota. Make two observations of the pattern of population change in the Midwest USA--the Dakotas through Oklahoma.

[The Midwest rural counties usually decreased, with some urban counties showing an increase.]

74) Make two additional observations about population change in the USA.

[Answers will vary. Florida shows an increase. Texas panhandle decreased, but Central Texas is characterized by high growth. Colorado is characterized by high growth in the Central part of the state, decreasing population in the plains section.]

75) Summarize in a few sentences what you have learned about population changes in the United States over the past 100 years in this lesson.

[Answers will vary. Population change is highly variable between rural and urban, and even among cities, and between regions.]

76) Summarize in a few sentences what you have learned about GIS in this lesson.

[Answers will vary, and could include querying, selection, 3D analysis, sorting, analyzing patterns, charts, layouts.]

Save your project and exit ArcView GIS.

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