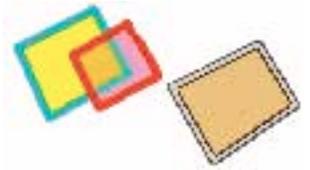


Mapping Rural Growth

Using Census 2000 Block Data



By Mike Price, ESRI Mining and Earth Science Solutions Manager

Editor's note: An article, "Mapping Census 2000 with ArcGIS," in the Spring 2002 issue of *ArcUser* described how to map demographic change on a national level using county level census data for 1990 and 2000. This article replicates the population growth analysis performed by a fire district in Utah to support its application for funds for an equipment purchase.

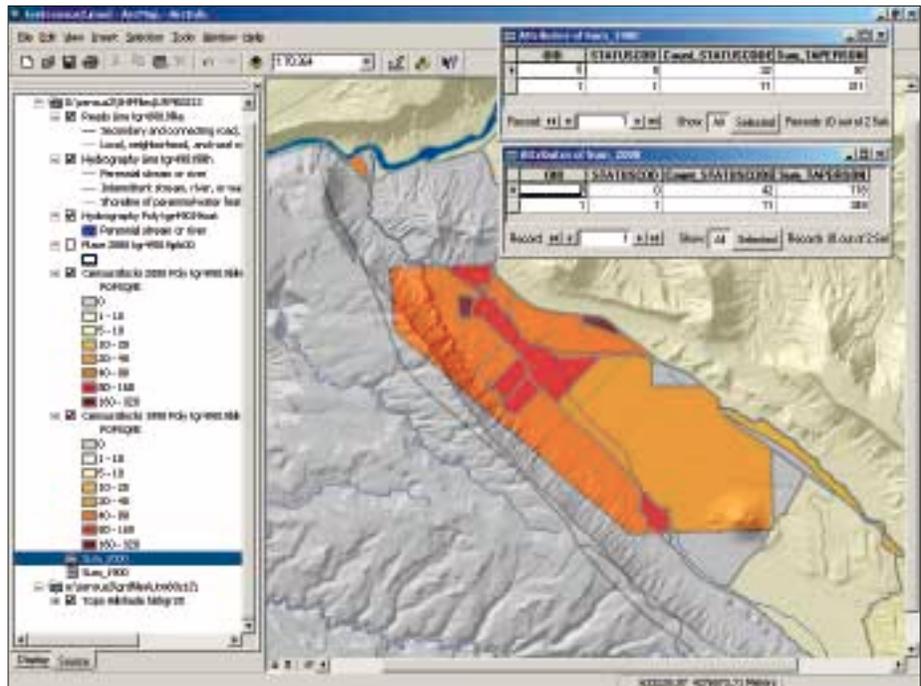
The Moab Valley Fire Protection District protects lives and property from fire, flood, man-made, and natural disasters in a 29.66 square-mile district that includes the City of Moab and adjacent lands in Grand County. By contract and through Memorandums of Understanding, the District also safeguards an extensive area outside the District that includes all of Grand County and a large portion of San Juan County to the south.

Growth in the Moab Valley

Southeast Utah and the Moab Valley have continued to experience population growth, both year round and transient (caused by recreational tourism in the area). The Grand County population base is rapidly expanding, both inside and outside the District. High value residences are being built in remote, previously uninhabited areas. As part of its efforts to provide reasonable protection to all area residents, the District submitted an application to obtain funding for a Wildland/Urban Interface pumper. In early 2002, the Federal Emergency Management Agency (FEMA) was authorized to distribute \$360 million in Firefighter Assistance Grant funding for one-year grants that would be given directly to fire departments in states.

To justify the request, District personnel summarized 1990 and 2000 census block data to show growth in the region. Census block shapefiles were obtained from the Geography Network and demographic data was provided by the Utah Automated Geographic Reference Center (AGRC). The data was compiled and mapped in Universal Transverse Mercator (UTM) North American Datum of 1983 (NAD83) Zone 12. The Moab Valley Fire District Census Block analysis included major portions of Grand and San Juan counties and was centered on the City of Moab.

This analysis revealed that, over the past 10 years, the population inside the District



Final map and output summary tables for Castle Valley.

increased by 27 percent, the population protected by contract rose more than 42 percent, and the District's response area increased by a whopping 67 percent. The data certainly supports the request for additional emergency response equipment to serve the District's hard-to-access areas.

Setting up the Data

The exercise described in this article uses census data to map the growth and population dispersion that occurred over the past 10 years in Castle Valley, an incorporated Utah town in a rural area near Moab. Data for the exercise has been preprocessed. Standardized population statistics were combined with census block data and Census Feature Class Codes (CFCC) were with TIGER shapefiles, building useful legends. To complete the following exercise, you will not need to download and process any census data. Simply visit the *ArcUser Online* Web site (www.esri.com/arcuser) to download a zipped file containing the tutorial data.

After unzipping the sample data using WinZip or a similar utility, create the directory structure shown in Figure 1 and place the files in the sample dataset as indicated. Open ArcCatalog and verify that all extracted data is properly loaded. Preview all raster and vector

Figure 1: Directory structure



datasets and check the projected coordinate system for this data by clicking on the Metadata tab and then the Spatial tab. The data should be registered in UTM NAD83 Zone 12 meters.

Click on ArcMap icon in ArcCatalog to launch ArcMap. Size the application windows so both are accessible. Drag and drop HLSDR20 and the six shapefiles from ArcCatalog to the map canvas. Right-click on each file and choose Properties from the context menu. Rename each layer using the names shown in Figure 2 but keep the source file name in the text string (e.g., tgr49019ka is renamed to Roads Line

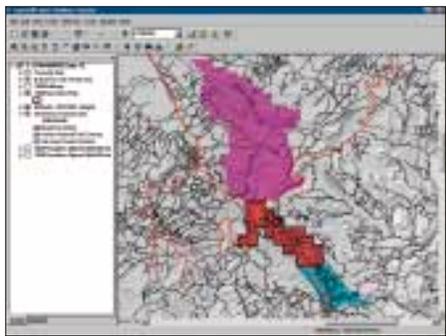
Figure 2: Layer names and order

File name	Layer name to add
tgr49019ka	Roads Line
tgr49019kh	Hydrography Line
tgr49019wat	Hydragraphy Poly
tgr49019plc00	Place 2000 Poly
hlshgr20	Topo Hillshade
tgr49019blk00	Census Blocks 2000 Poly
tgr49019blk90	Census Blocks 1990 Poly

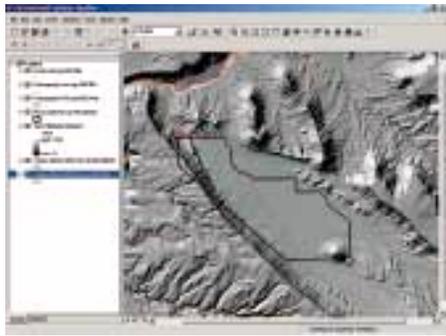


What You Will Need

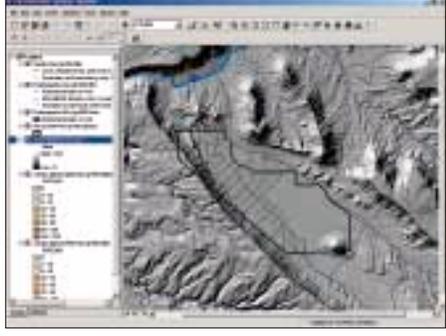
- ArcGIS 8.1 Desktop (ArcInfo, ArcEditor, or ArcView license)
- An Internet browser and connection
- Sample data from the *ArcUser Online* Web site
- WinZip or a similar unzipping utility



The Moab Fire District (shown in red) and contract regions shown in blue and purple. Response areas covered by Memorandum of Understanding are shown in gray.



After unzipping, loading, and checking the data, provide more meaningful names for each layer.



Symbolize the layers by importing and applying ArcView 3.x legends.

tgr49019ka). Drag layers to place them in the order shown in Figure 2. The Roads Line and Hydrography Line layers should be at the top of the stack followed by the Hydrology Poly and Place Poly layers, the Topo Hillshade, Census Blocks 2000 Poly, and Census Blocks 1990 Poly layers.

Thematic Mapping, Enhancing Our Map

To make legend creation easy, ArcView 3.x legend files (.avl files) are provided for each shapefile. Right-click on each shapefile in the Table of Contents and choose Properties. Click on the Symbology tab and click on the Import button. In the Import Symbology dialog box, click on the radio button next to “Import symbology from an ArcView 3.x legend” and browse to avl file with the name corresponding to layer. Use tgr49019blk.avl file for both 1990 and 2000 census data layers and assign the symbology to POPSQMI field. Because values have not been calculated for the POPSQMI field, both census block layers will be displayed in gray. For other shapefiles, assign symbology to the DESCRIPTIO field. To make layer easier to recognize, expand the legend for each layer. Save the map document.

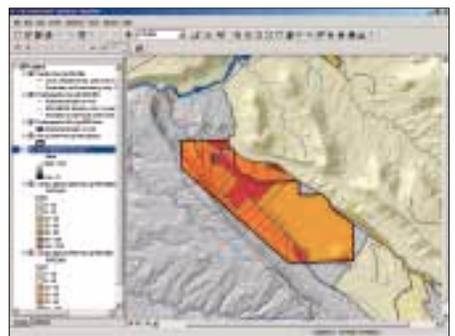
Right-click on the Topo Hillshade layer, choose Properties, and click on the Display tab in the dialog box. Set the transparency to 60 percent and click Apply. The outlines of Census Blocks 2000 Poly layer will be visible. Turn this layer off to reveal the simplified Census 1990 block outlines.

Calculating Population Per Square Mile by Block

In the Table of Contents, right-click on the Census Blocks 2000 layer and choose Open Attribute Table. This table contains attributes for 53 records. Each record has fields for the area in square miles (AREASQMI), the total population (TAPERSON), population per square mile (POPSQMI), and a selection code (STATUSCODE). Notice that the POPSQMI and STATUSCODE fields contain zeros. The next procedure will calculate values for these fields.

1. To calculate population per square mile, right-click on the POPSQMI field header and elect Calculate Values from the context menu.
2. An ArcMap message warns that these calculations will take place outside of an edit session and cannot be undone. Click OK.
3. Use the expression [TAPERSONS] / [AREASQMI] to calculate the population per square mile. Either type it into the Field Calculator or click on the desired field names and operator to form the expression. Make sure that the expression has been correctly entered and click on OK. The field will be calculated.
4. Right-click on POPSQMI and sort the just calculated values in descending order.
5. The values, ranging from almost 200 to 0, indicate the number of persons per square mile. Close the Attribute Table. Click the Refresh View icon located on lower left side of the map canvas.

Open the attribute table for Census 1990 Blocks and repeat same process for calculating POPSQMI values. Inspect the 1990 distributions. Are there any significant changes? Turn 2000 Census Blocks off and on (or use the Effects toolbar to vary the transparency of the Census Blocks 2000 layer) to see the changes that have occurred over the last 10 years. The same thematic legend has been applied to both datasets. Pay particular attention to Castle Valley on the Colorado River corridor to the north.



Set the transparency for the hillshade layer to 60 percent so the census block layers can be seen.

Coding Census Blocks In and Out of Town

With the 1990 and 2000 Census Block data for Castle Valley thematically mapped it is clear there have been some significant changes. The population has significantly increased and is more dispersed. These changes must be analyzed and summarized in order to demonstrate the District’s contention that rural emergency services have been stretched by growth and expansion.

Remember the STATUSCODE fields in 1990 and 2000 Census Block tables? These fields will be populated with a code that will select census blocks that are within the Castle Valley town limits using Select by Location. From the menu, choose Selection > Select by Location. In the Select by Location dialog box, use the drop-down boxes to select features from the Census Blocks 2000 Poly and Census Blocks 1990 Poly layers that have their center

Figure 3: Select by location choices

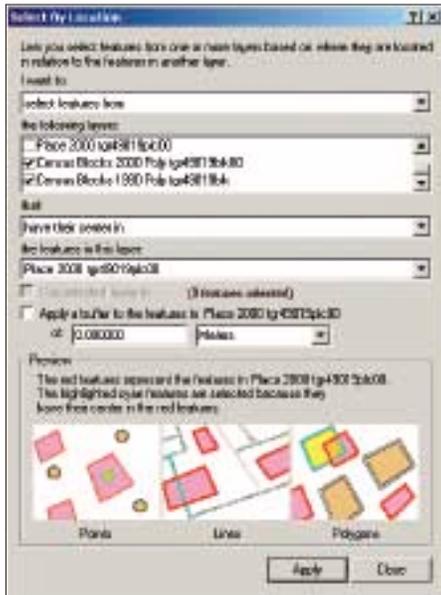
Dialog box option	Choice from drop-down box
I want to:	select features from
The following layers:	Census Blocks 2000 Poly and Census Blocks 1990 Poly
That:	Have their center in
The features in this layer:	Place 2000

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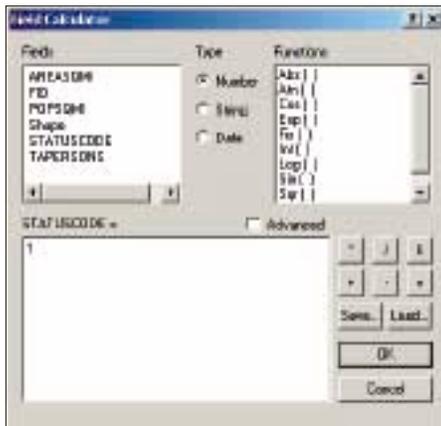


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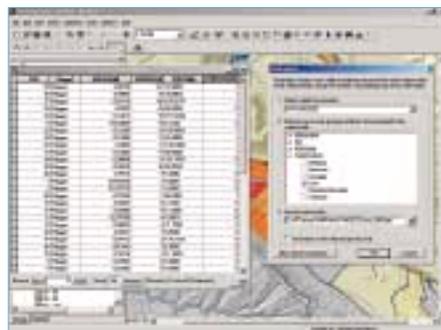
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Use *Select by Location* to identify blocks inside Castle Valley city limits so they can be coded and summarized.



Use the *Field Calculator* to populate the *STATUSCODE* field of the selected blocks.



Summarize both tables on the *STATUSCODE* field and generate *Sum* statistics using the *TAPERSONS* field. Add the output tables to the map.

in the Place 2000 layer that describes the Castle Valley city limit. The drop-down box choices are shown in Figure 3.

Click Apply and observe both Census Blocks Poly themes. The outlines for block polygons were made a bit heavy so that the selected sets, outlined in cyan, would be easy to spot. Notice that some significant areas of population are located outside of the town limit. This is especially true for 2000 census data.

The selected features will be coded with a new value. The coding scheme is simple. A zero value means that the census block is outside the town limits and value of 1 means the block is located inside the town of Castle Valley. Open the attribute table for each census block theme.

1. Right-click on one of the census block layers and choose Open Attribute Table.
2. To display just the selected features for the table, click on the Selected button next to Show: at the bottom of the table frame. Only the selected and highlighted records are visible.
3. Right-click on the STATUSCODE field and choose Calculate Fields from the context menu.
4. Type 1 in the Field Calculator to populate the STATUSCODE field and click OK. These calculations will be performed outside of an Edit Session and cannot be undone. If things go terribly wrong, deselect all features, reset all fields to zero, reselect, and reapply a 1 value to selected features.
5. Once the calculations for both tables are complete and correct, save the project.

Summarizing the Data

The next to the last step is to summarize the total population field (TAPERSON) as using STATUSCODE to separate blocks inside the town limits from those outside. Both the 2000 and 1990 blocks will be summarized.

1. Open the Census Blocks 2000 table.
2. Sort the TAPERSON field in descending order. Note that most of the selected blocks will be near the top.
3. At this point, just the blocks inside the town could be summarized by evaluating only selected records. However, there is significant growth outside of town, so all the records will be included. Choose Selection > Clear Selected Features from the menu to include all blocks in the summary.
4. Right-click on the STATUSCODE field name in the table and select Summarize from the context menu.
5. In the Summarize dialog choose STATUSCODE as the field to summarize. Check the box next to Sum under TAPERSONS and specify a location for the output table and

name it Sum_2000.dbf.

6. Click OK to close the dialog box and click on OK again to add the results to the map.
7. Open the attribute table for Census Blocks 1990 and summarize it using the same procedure. Save the resulting table as Sum_1990.dbf and add it to the map.

When the Moab Valley Fire Protection District calculated statistics to support the fire grant, their calculations were slightly more complex. Three codes—In District, Agreement Area, and Response Area—were used. In the Castle Valley example, only two categories are used. STATUSCODE = 1 represents the area in the District and STATUSCODE = 0 is a clipped portion of the Response Area.

Summarizing the Population and the Story

These calculations show the increase in population in and around Castle Valley between 1990 and 2000. Right-click on each summary table and choose Open. The population has increased from 211 in 1990 to 349 in 2000, or more than 65 percent. The results of these summaries are shown in Figure 4.

As demonstrated by this analysis, Castle Valley is experiencing many of the same growing pains as nearby Moab Valley. Grand County

Figure 4: Results of Castle Valley population growth analysis

	Population 1990	Population 2000	Population Change	Percent Change
Castle Valley town	211	349	138	65.4
Adjoining Area	97	118	21	21.6
Total	308	467	159	51.6

elected officials, emergency managers, and planners face a tremendous challenge in providing a safe comfortable environment for the County's rapidly growing population. Although the data has been preprocessed and simplified for the exercise, it demonstrates the methodology for using ArcGIS with census data to measure population change between 1990 and 2000 and solve a real-world problem. Skilled GIS users can perform similar analyses using the block level census data as it is released by the Census Bureau. ■

Disclaimer

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Please remember to back up your data prior to using this information.