SUMMARIZE
INFORMATION BETWEEN GRIDS

by Peter J. Ersts, American Museum of Natural History

Editor's note: *This article presents a simple method for summarizing several grids using ArcView 3.1 with the ArcView Spatial Analyst extension.*

There are many situations in which you might like to summarize information between two or more grids. For example, if you want to look at changes in the health of coral over time with respect to depth and distance from the shore, you could vectorize one or more of the grids and use Summarize Zones, a function available from the ArcView Spatial Analyst extension, or you could write an Avenue script that would automate, organize, and output the data in the desired format. Either option can be time-consuming and cumbersome. A simple solution is to use basic algebraic equations and the Map Calculator in the ArcView Spatial Analyst extension to create a new grid.

A PRACTICAL EXAMPLE

Say you are interested in analyzing, by elevation, changes in land cover or land use on a countrywide basis. This sample analysis will use data derived from satellite imagery in areas up to nine kilometers from rivers and will use three grid themes, all captured at the same resolution, and one vector theme. Ultimately you plan to use an external statistics package for more advanced multivariate analysis. This may seem like a daunting task to a GIS newcomer, but it is actually quite easy and will require you to

1. Assemble or gather the necessary land cover or land use dataset for the temporal analysis.
2. Assemble or gather the elevation dataset.
3. Create a new theme by buffering rivers to a distance of nine kilometers.
4. Rasterize the buffer theme using the same cell size as the land use or land cover and elevation grids.
5. Create a new grid with the information from the two land use or land cover grids, the elevation grid, and the buffer grid.
6. Export the data in a format that can be used by the statistics package.
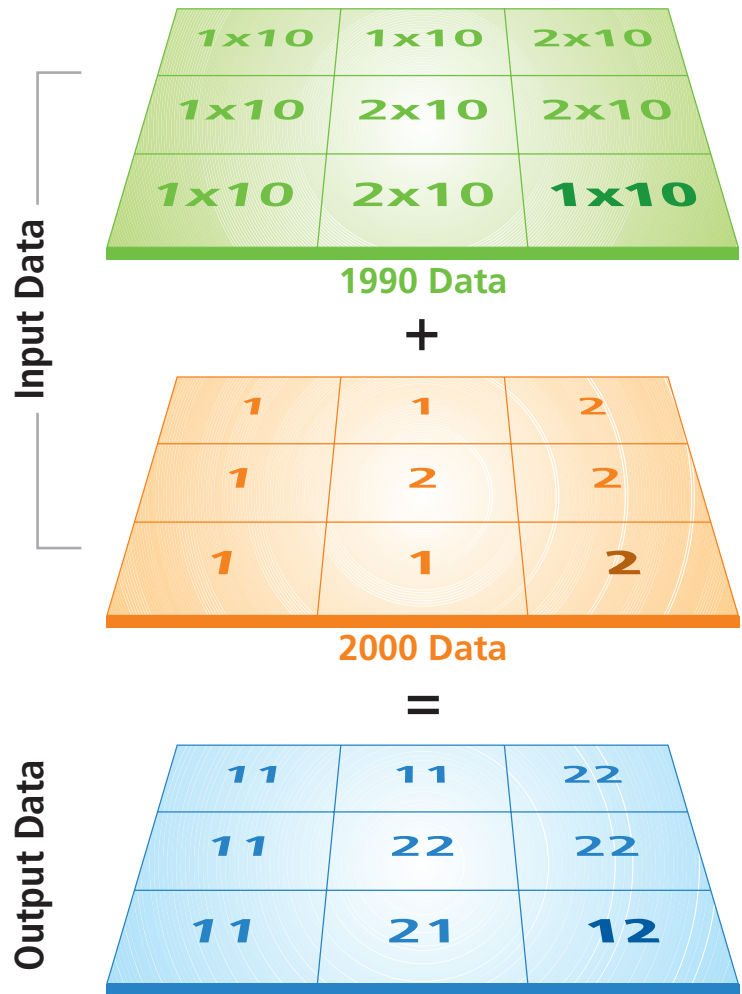
The first four steps are fairly obvious, but step five is where the real magic of using grids starts. In this example you are examining changes in land cover between 1990 and 2000 for a particular country. Each land cover grid has only five classes (forest = 1, nonforest = 2, water = 3, cloud = 4, shadow = 5). You could start by creating a series of new grids using the Map Query tool available from the Analysis menu in ArcView Spatial Analyst, or you could just combine the grids.

ANALYZING CHANGE OVER TIME

If a grid cell located in the land cover grid for 1990 has a value of 1 (forest) and the same cell in the land cover grid for 2000 has a value of 3 (water), combining the grids will result in that cell having a value of 13, denoting a change from forest to water. Combining grids using this method generates cell values that demonstrate change over time. A value of 11 denotes no change in forest coverage, 12 shows a change from forest to nonforest, and 21 a regeneration of nonforest to forest.

If you are working only with integers, you can obtain the area for each class interaction simply by multiplying the number of cells containing a specific value (contained in the count field) by the square of the cell size. With this method you can regress combined data back to the original grids. Things get more complicated if you are working with real numbers or dealing with more than two grids.

Before you start combining grids, it is important to investigate and

Input Data

1990 Data

1x10	1x10	2x10
1x10	2x10	2x10
1x10	2x10	1x10

+

2000 Data

1	1	2
1	2	2
1	1	2

=

Output Data

11	11	22
11	22	22
11	21	12

understand your data. Let's assume for this example that the land cover grids, 1990LC and 2000LC, have the form 1 <= 1999LC and 5 >= 2000LC, elevation (E) is explained as 0 <= E <= 3000, and river buffers (RB) follow the form 1 <= RB <= 9. You will need to compute an offset that will scale each grid so that they are added together without overlapping cell values. Adding the land cover grids together without first multiplying one of the grids by a power of 10 to separate the values would result in values that would not show the relationship between the two grids (e.g., a resulting value of 4 could indicate no change in nonforest land, 2 + 2, or a change from forest to water, 1 + 3. Listing 1 shows an easy way to offset the two land cover grids.

LISTING 1
```
NewGrid(x,y) = (1990LC(x,y) * 10 ) + 2000LC(x,y)
'Where: 1990LC(x,y) is your 1990 land cover grid;
'   2000LC(x,y) is your 2000 land cover grid; and
'   x and y are the columns and rows.
```

Now, let's see how to combine multiple grids. Using the equation already presented above, you can describe the two land cover grids with the following formula:

$$NewGrid(x,y) = (1990(x,y) * 10) + 2000(x,y)$$

Next, add the elevation data. Because the combined land cover classes can have a maximum value of 55, the elevation grid must be scaled by 100 to move it one place value beyond the other values.

```
NewGrid(x,y) = (E(x,y) * 100) + (1990(x,y) * 10)
+ 2000(x,y)
```

The output grid can now have a maximum value of 300,055. In order to add the river buffers, you must scale the values for this grid by 1,000,000.

```
NewGrid(x,y) = (RB(x,y) * 1000000) + (E(x,y) *
100) + (1990(x,y) * 10) + 2000(x,y)
```

Listing 2 demonstrates how to compute a new grid cell value from multiple grids—two land coverage grids, one elevation grid, and one river buffer grid. Use the following data: 1990LC(100,100) = 1, 2000LC(100,100) = 3, E(100,100) = 2000, and RB(100,100) = 2.

Listing 2

```
NewGrid(100,100) = (2 * 1000000) + (2000 * 100) + (1 * 10) + 3
NewGrid(100,100) = 2000000 + 200000 + 10 + 3
NewGrid(100,100) = 2200013
```

Preparing Data for Export

Congratulations, you have just merged four grids! Now you can go on to step six and export data to a statistics package. Turn the grid into a point theme by using GRID2PT, an Avenue script written by Jeff Ardron that is available from the ArcScripts page of the ESRI Web site. This script generates a nice fat dBASE (DBF) file. Each record in this file represents one grid cell. If this is a countrywide grid, the new point theme may contain thousands of points.

Add a new field to the attribute table of the point theme for each grid that was originally used so that you can scale the data back to its original form. After adding fields, undo value scaling and cell addition using the Map Calculator to populate the new fields. Listing 3 illustrates this process. Some type of truncate function should be used to remove the decimal portion of the number. This value should not be stored in a temporary nondecimal field as rounding will occur.

This is a very simple and powerful technique for analyzing grids. Although this example only shows integers, real numbers can easily be

Listing 3

```
RiverBuffer = (grid-code / 1000000).truncate
Elevation = ((grid-code - (RiverBuffer * 1000000)) / 100).truncate
1990LC = ((grid-code - (RiverBuffer * 1000000) - (Elevation * 100)) / 10).truncate
2000LC = (grid-code - (RiverBuffer * 1000000) - (Elevation * 100) - (1990LC * 10))
```

scaled into integers and still retain enough significant digits. This article provides a brief introduction. Explore this idea further to understand its utility and potential. Remember, the simplest solution is not always the most obvious. **AU**

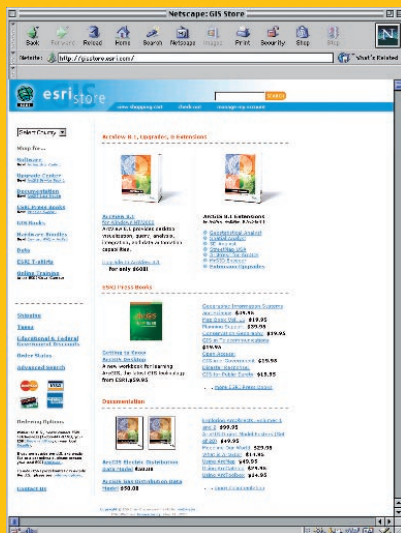For more information on this article, contact

Peter J. Ersts
American Museum of Natural History
Center for Biodiversity and Conservation
79th Street and Central Park West
New York, New York 10024
E-mail: ersts@amnh.org

About the Author

Peter Ersts is currently studying spatial and behavioral aspects of habitat preference among humpback whales in Madagascar. He has also organized and presented workshops to biodiversity professionals, students, and nongovernmental agencies in Bolivia, South Africa, and Vietnam; used remote sensing and GIS to assist biodiversity surveys; and provided supplementary data, such as rates of deforestation, for protected-area feasibility studies.