Using ArcMap to Enhance Topographic Presentation

David Barnes

The first part of this article discusses some of the basics of terrain representation using ArcMap. The last part goes into a little more detail about how to achieve a Swiss-style hill-shade effect using the Spatial Analyst extension.

Preparing the grid

For display purposes if you want to mask out portions of a grid it is better to overlay polygon data rather than using the Workstation Gridclip command. This will help avoid grid cells showing along the edges between the masked and non-masked areas.

If you will be displaying the grid in a different coordinate system from the original it is best to reproject the grid in Workstation using the Project or ProjectGrid commands. This will speed up drawing in ArcMap as the grid will not have to be reprojected on the fly.

Setting Symbology

Once you have opened ArcMap and added your raster layers you can adjust the symbology.

Right-click on the raster layer in the Table of Contents and select Properties.

Select the Symbology tab.

In the Symbology dialog you can choose one of the Renderer options. A Stretched renderer is good for terrain data. This produces smooth transitions of colors across the raster.

Next you can choose one of the built-in color ramps or edit one to suit your needs. For hill-shade grids it is best to use a monochromatic color ramp, but you don't have to be limited to grayscale. For example, a bathymetry hill-shade grid looks good with a blue color ramp, or try a warm color ramp for desert terrain. For hypsometry multi-hue color ramps often look best.

If you don't find any of the existing color ramps suited to your needs you can edit an existing ramp.

To edit a color ramp right-click on the ramp you want to edit in the dropdown list in the Layer Properties > Symbology tab and select Properties.

In the Edit Color Ramp dialog box you can delete individual color ramps from a multi-part color ramp, change the order of the individual color ramps in a multi-part color ramp, edit the properties of any existing individual color ramps, or add a new color ramp to the current color ramp (*Figures 1 and 2*). You will want to make sure the adjoining colors from two neighboring color ramps within a multi-part color

ramp are identical to ensure a smooth transition along the entire ramp. You might want to remove the first or last color ramp from a multi-part color ramp, for example to remove the white and light colors from the top of a ramp when the terrain you are mapping does not include any high snow-covered peaks.

Setting Display Properties

You can also use Display properties to adjust the appearance of the terrain on your map.

Right-click on the raster layer in the Table of Contents and select Properties.

Select the Display tab.

The two main options you will want to use are the resampling methods and the transparency setting.

The bilinear resampling method works best for terrain. This method results in a smooth transition between pixels/cells across the entire surface. Nearest neighbor does very little smoothing and works best for discrete data. Cubic convolution doesn't smooth as much as bilinear and works best for imagery, such as satellite images and aerial photographs.

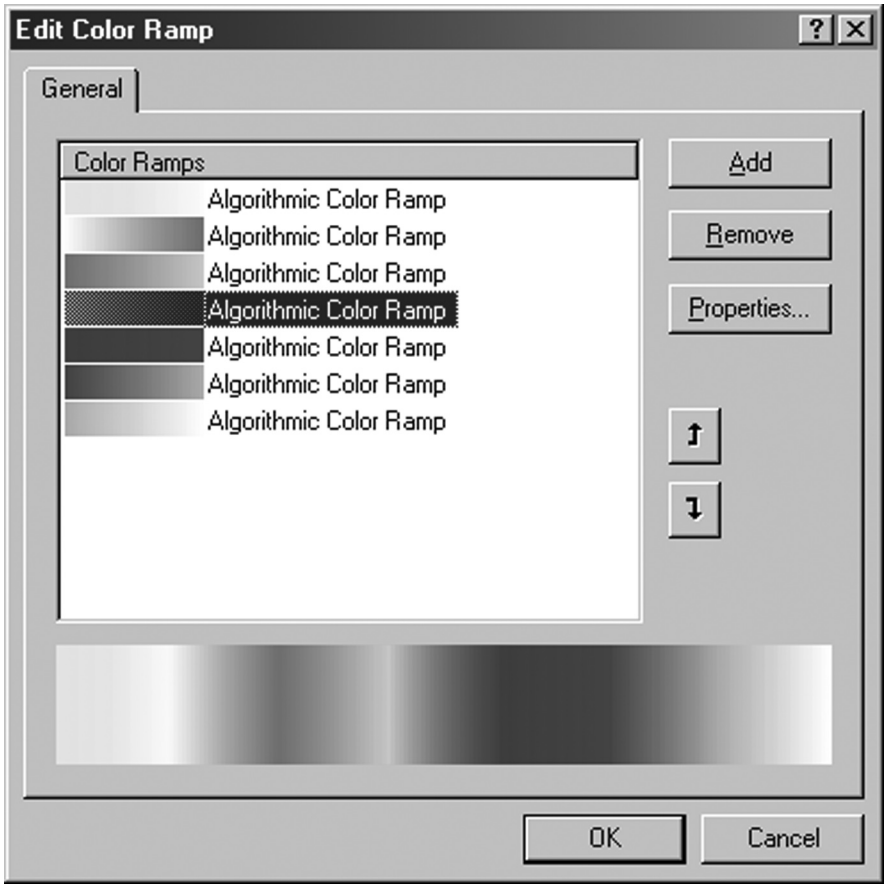

Figure 1. Dialog for editing multi-part color ramps

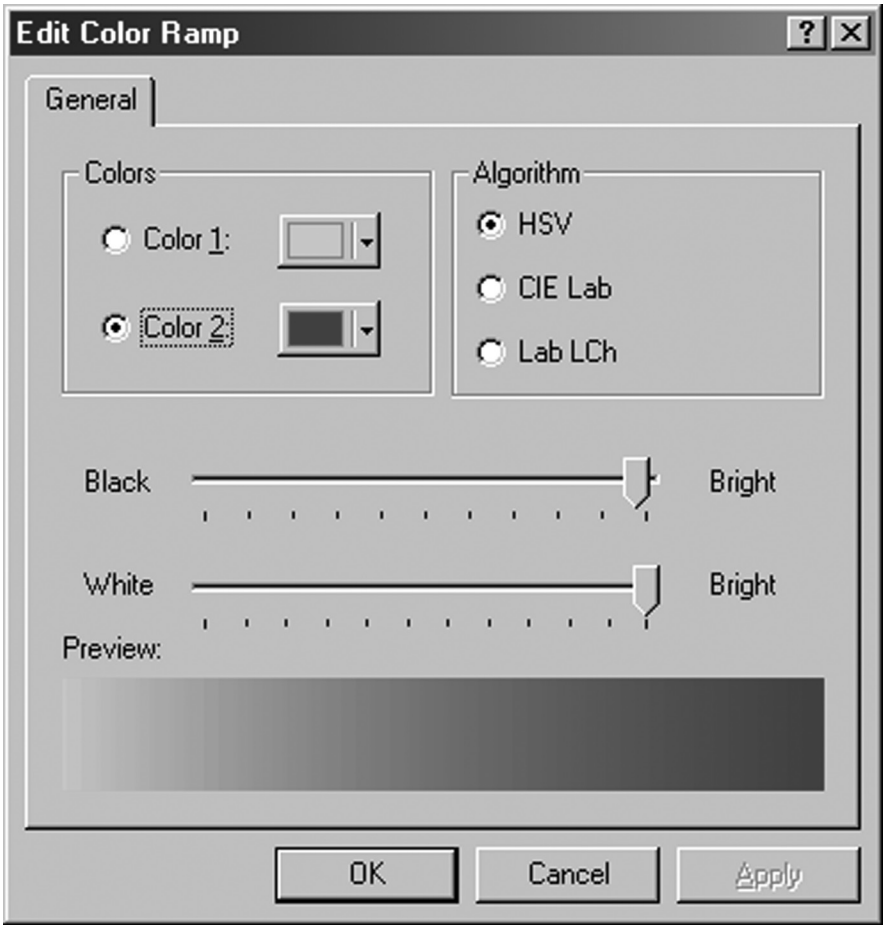

Figure 2. Dialog for editing algorithmic color ramps

Transparency can be used to allow underlying layers to show through, for example to show a hill-shade under a hypsometric layer. Transparency can also be used to tone down the intensity of layers, for example, to lighten the shadows of a hill-shade.

Combining Multiple Rasters

You can combine multiple layers by using transparency to allow underlying layers to show through, as noted above. For example, you can place a hypsometric layer such as a DEM (digital elevation model) or a satellite image on top of a hill-shade layer, and then set a percentage of transparency on the uppermost layer. You can also reverse the order and put the hill-shade on top for different effects.

Effects Toolbar

To open the Effects toolbar navigate to the View menu, select Toolbars, and select Effects from the list (*Figure 3)*.

The Effects toolbar allows you to choose which layer any effects will be applied to, and also has controls for adjusting transparency, as well as contrast and brightness. The latter two controls only apply to raster layers and can be used to perform tasks such as heightening the contrast between light and dark areas of a hill-shade or to lighten the appearance of a raster layer without making it transparent.

Figure 3. Effects toolbar

Spatial Analyst

Thanks to intern Stephan Geissler of ESRI for the examples and methods described below.

In addition to the standard ArcMap functionality described in the previous sections, the Spatial Analyst extension includes many useful tools for terrain representation. In particular, the raster calculator can be used to create new layers based on existing layers. You can use the raster calculator with a median filter on an existing hill-shade to produce a smoother hill-shade layer. Then you can combine the two hill-shade layers with another raster calculation to produce an effect similar to Swiss-style hill-shading as described by Imhof in *Cartographic Relief Presentation*.

Swiss-Style Hill-Shading with ArcMap and Spatial Analyst

To do this you will start by adding your original hill-shade layer to ArcMap.

Next, in the Spatial Analyst toolbar click on the drop-down menu and select Neighborhood Statistics.

Set the Statistic type to Median, the Neighborhood to Circle, and the Radius to 4 cells.

Click Okay to create a temporary output grid. You can make this grid permanent later if you want.

The Median filter generalizes the terrain to emphasize the major geographic features, minimizes minor features, smoothes irregularities on the slopes, but maintains the rugged characteristics of the ridge tops and canyon bottoms.

The next step is to create another layer using the Raster Calculator.

Add your original DEM to the map.

In the Spatial Analyst toolbar click on the drop-down menu and select Raster Calculator.

In the Calculator use the following formula:
[DEM]/5 + [Hill-shade]
Where DEM = the name of the DEM from which the hill-shade was derived, and hill-shade is the name of the hill-shade layer

This simulates aerial perspective by making the higher elevations lighter and the lower elevations darker.

Now you have three raster layers, which you can combine with transparency to produce the desired effect. Place the layers in the following order, with the percentage transparency shown:

Front-most: original DEM, symbolized with a stretched renderer using a color ramp such as one of the elevation ramps, transparency around 55%

Middle: raster from neighborhood statistics with median filter, symbolized with a stretched renderer using a single hue color ramp such as grayscale ramp, transparency around 35%

Back-most: raster from raster calculator, symbolized with a stretched renderer using a single hue color ramp such as grayscale ramp, no transparency

The numbers used in the above example are only suggestions. Feel free to experiment to find out what works best for particular terrain and effects. This method is most suitable to more rugged terrain, such as the Alps or the Rocky Mountains.

The following examples, in 2 dimensions and 3 dimensions, represent the same geographic area (*Figures 4, 5, 6, and 7*).

Other effects can be achieved by experimenting with the various Spatial Analyst tools and core ArcMap functionality.

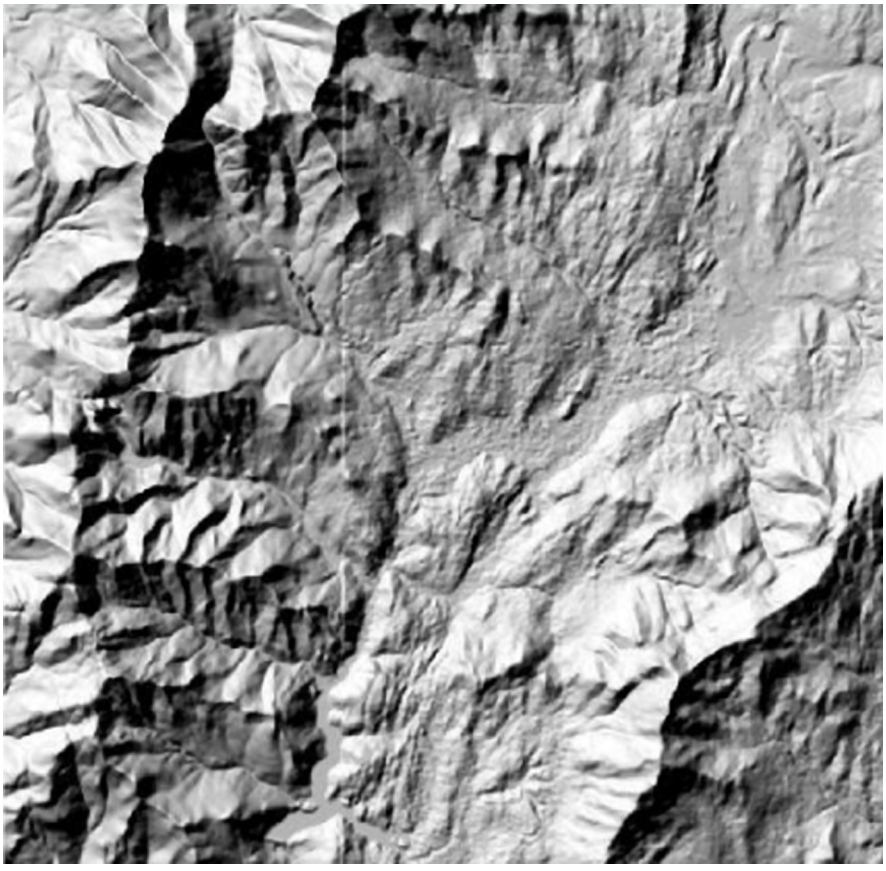

Figure 4. Standard hill-shade

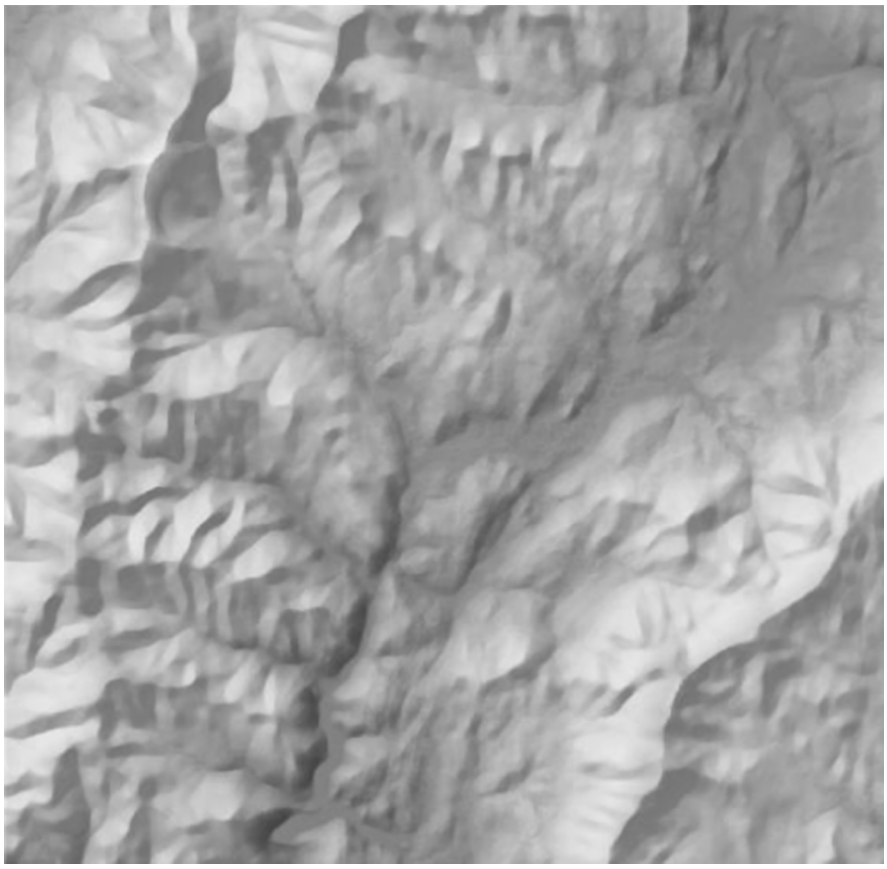

Figure 5. Swiss-style hill-shade

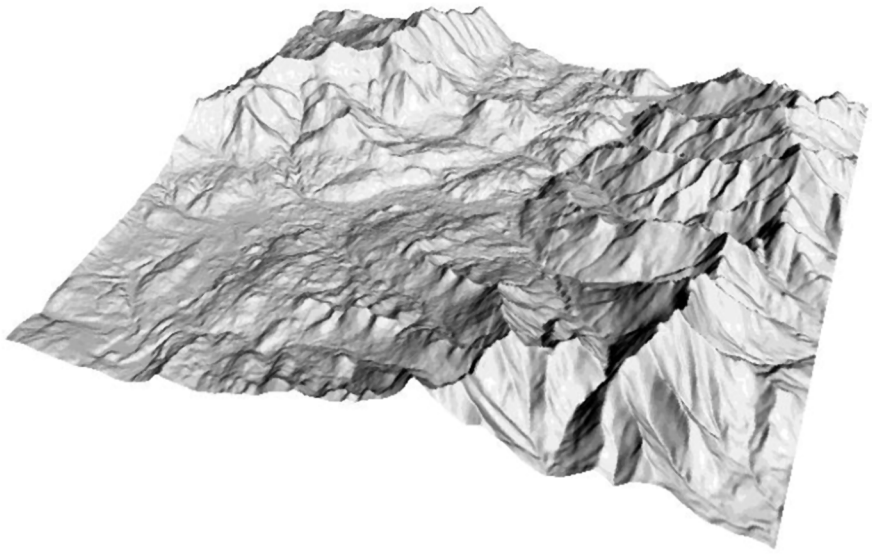

Figure 6. Standard hill-shade in 3-D

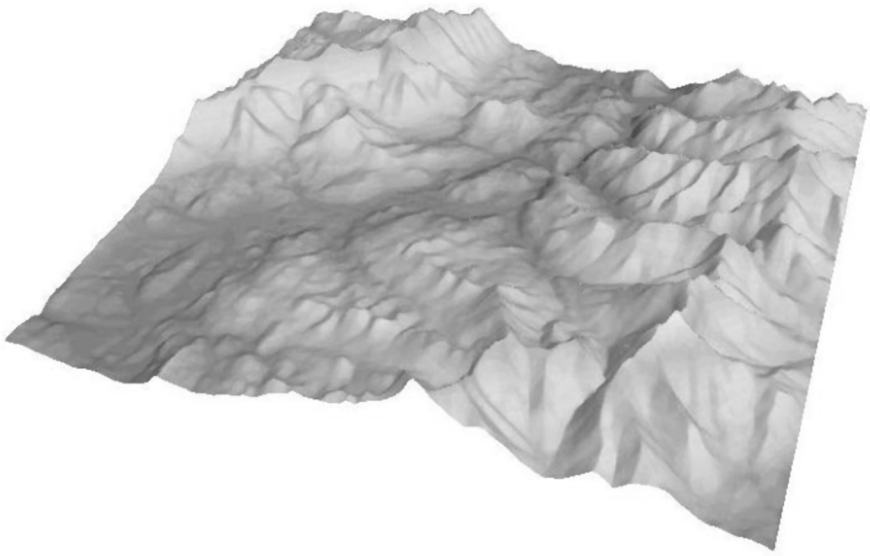

Figure 7. Swiss-style hill-shade in 3-D