Lesson 52: Surface visualization

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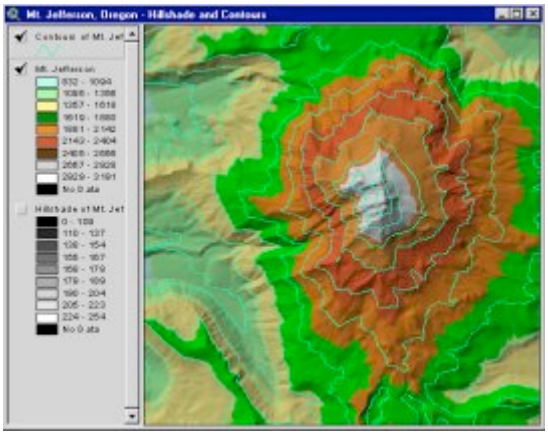
Surface visualization tools

How do you visualize three-dimensional surface data in a two-dimensional environment? Hillshades and contours are two ways to accomplish this.



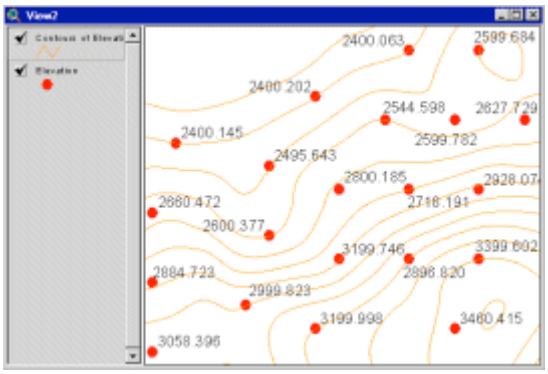
A hillshaded grid theme of Mt. Jefferson, Oregon with contours. The contour interval is set at 200 meters.
[Click to enlarge]

Hillshaded relief maps are perhaps the most valuable tool for displaying a surface. Hillshade grids compute illumination values for an elevation grid and are extremely useful for displaying elevation surfaces in relief. Hillshading portrays surfaces by casting shadows, duplicating the way we recognize land surfaces from the air. The user controls the position of an imaginary light source to create the shadows.

Contour lines, or isolines, are probably the most familiar representation of terrain surfaces. While they don't present as clear a visual picture of the surface as hillshading, with careful and experienced interpretation, contour lines can provide a wealth of information. These lines are generated at a specified distance, referred to as the interval, using a z value. For surface terrain models, contour lines are often used to represent terrain topography in a two-dimensional format

Creating contours

Contouring is a useful tool for visualizing surfaces. There are many contouring algorithms in use; the one used by ArcView Spatial Analyst is optimized for engineering accuracy, not necessarily for aesthetic quality.

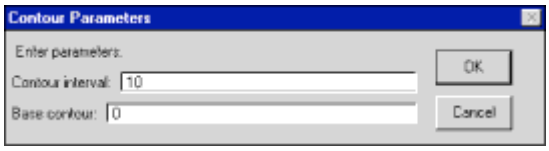


A contour line theme created from sample elevation points. [Click to enlarge]

Lines connecting points of equal value given a surface or some sample points are known as isolines. The following are all examples of isolines:

- Contour lines--lines connecting points of equal elevation
- Isobar--equal barometric pressure
- Isochron--connecting lines of equal time
- Isohel--equal duration of sunshine
- Isohyet--equal rainfall
- Isoseismal--earthquake shock intensity
- Isotherm--equal temperature
- Isogonic--equal magnetism

A contour line theme (line shapefile) can be created from continuous data in a grid theme or from sample points in a point theme. When creating contours from a point theme, either IDW or Spline may be chosen as the interpolation method. After the surface is interpolated, you can specify a contour interval and base contour.



The Contour Parameters dialog. [Click to enlarge]

The contour interval is the change in z value between output contour lines. A value of 10 creates a contour every 10 feet (if your units are in feet). If the input theme has negative values, negative contours will automatically be generated in those areas.

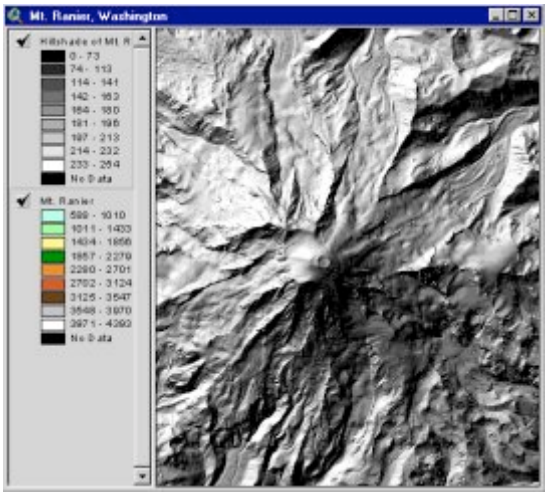
The base contour is a starting location. It is not the minimum contour. It refers to a starting point from which contours go both above and below based on the contour interval. For example, if the base contour was set to 0 and the interval was set to 10, the resulting contour values would be -20, -10, 0, 10, 20, and 30.

Another method for creating contours is the Contour Line tool  . To create a contour line, you simply point to a location on a surface grid and click. One contour line is created by connecting all other locations with the same value as the selected location

Hillshading

Hillshading is a visualization tool that computes surface illumination as values from 0 to 255 based on light source angle and elevation. The azimuth and altitude control the hypothetical position of the sun. For best visualization, the azimuth is set to 315 and altitude is set to 45 to artificially cast a shadow at the bottom of the object (mountain). The eye tends to see objects better when the shadow is cast at the bottom of the object. Reversing the light source position often has the effect of making hills appear to be depressions.

Hillshading is typically used to create a shaded relief grid theme from a surface theme. Hillshading analysis is also important for determining the amount of time a given cell receives sunlight and the intensity of that sunlight.



A hillshaded grid theme of Mt. Ranier in Washington State created with the Spatial Analyst Compute Hillshade function. [Click to enlarge]

For example, in siting a housing development, a hillshade theme may be created by considering the sun location. The new houses could be located on the sunny sides of hills to save on heating costs.

You can create a hillshade grid either by choosing Compute Hillshade from the Surface menu or by using the Hillshade request in the Map Calculator. The major difference between the two methods is that you can specify a zFactor with the Hillshade request. The zFactor can be used to exaggerate the z values for more effective display. You can also use the zFactor to make the z value units the same as the x,y units.

Avenue syntax:

```
aGrid.HillShade(anAzimuth, anAltitude, zFactor )
```

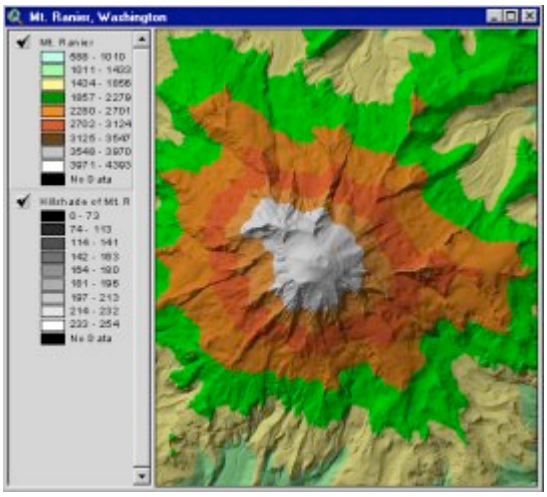
Example:

```
[Elevation].Hillshade(315, 45, 4)
```

- The azimuth is the angular direction of the sun, measured clockwise from the north in degrees from 0 to 360. If the sun is located due east, its azimuth is 90 degrees. An azimuth of 270 is due west. The default azimuth is 315 degrees.
- The altitude is the sun's angle of elevation above the horizon. The degree units are measured from 0 at the horizon to 90 degrees, which would be directly overhead. The default altitude is 45.
- zFactor is a number for vertical exaggeration. It defaults to 1 if Nil is entered.

A hillshade theme can enhance the relief of a surface when used as the brightness theme for the display of another grid theme. Setting a brightness theme is also the only way to display

two grids at once as cells always have a solid fill pattern. (Grid cells can never be symbolized with dotted or dashed patterns with a transparent background.) You can set a brightness theme using the Advanced button in the Legend Editor.



An elevation theme of Mt. Ranier with its hillshade applied as a brightness theme. [Click to enlarge]

Exercise

Create contours

Portraying the land surface with contours provides a highly metrical portrayal of elevations and slopes. Even so, landforms can be visualized upon careful examination of contour maps. In this exercise, you will create contours first from a set of sample points and then from an elevation surface.

If you have not downloaded the exercise data for this module, you should download the data now.

Step 1 Start ArcView

Start ArcView and load the Spatial Analyst extension.

Note: If you are running ArcView GIS 3.1, you see a Welcome to ArcView GIS dialog. Click Cancel to close this dialog.

If ArcView is already running, close any open projects.

Step 2 Open the project

From the File menu, choose Open Project. Navigate to the **surfalsa\lesson2** directory and open the project **l2_ex01.apr**.

Note: If you are running ArcView GIS 3.1, you see an Update l2_ex01.apr message box. Click No to dismiss this box.

When the project opens, you see an Elevation view containing a point theme of sample elevations.

VIEW RESULT

Step 3 Examine the sample points

You'll start by examining the sample point theme attributes.

Make the Samples theme active, then click the Open Theme Table button  to examine the attributes of the sample point theme. The Spot field contains elevation values for the sample points.

Make the Spot field active and choose Statistics from the Field menu.

VIEW RESULT

Notice that the maximum elevation point is about 3782 feet and the minimum is about 1582 feet. The range in elevations is about 2200 feet. These figures can help you select an appropriate contour interval.

Choose OK to close the Statistics for Spot field window and also close the Attributes of Samples table.

Step 4 Create contours from elevation points

Make the Elevation view the active window. From the Surface menu, choose Create Contours.

In the Surface Grid Specification dialog, use Same as Display for the Output Grid Extent. Click OK.

In the Interpolate Surface dialog, choose Spline as the method, Spot for the Z Value Field, **0.1** as the Weight, **6** for the Number of Points, and Regularized as the Type. Click OK.

In the Contour Parameters dialog, choose **200** as the Contour Interval and **0** as the Base Contour. Click OK.

The contours are created. When the Contours of Samples theme appears, turn it on.

VIEW RESULT

Can you tell what feature is represented in the center of the view? Without labeling, it is difficult to interpret the contour lines. In the next step, you will label the contour lines.

REVIEW CONCEPT

Step 5 Label contour lines

Turn off the Samples theme and make Contours active. From the Theme menu, choose Auto-label.

In the Auto-label dialog, choose Contour for the Label field. Choose On for Line Label Position Options. Use the default settings for the remainder of the choices. Click OK.

VIEW RESULT

Now can you visualize the feature in the center of the view? With the contour lines now labeled, it is apparent that the feature is a hill. Without the labeling, the feature could just as easily been a depression in the surface.

Next, you will learn how to create contours from an elevation surface.

Close the Elevation view.

Step 6 Create contours from an elevation surface

From the Project window, open the Mt. Shasta view. When the view opens, you see a grid theme of elevation.

Make the Elevation theme active, then from the Surface menu, choose Create Contours.

In the Contour Parameters dialog, choose **100** as the Contour Interval and **0** as the Base Contour.

Click OK to create the contours. When the Contours of Elevation theme appears, turn it on.

VIEW RESULT

Can you tell what feature is represented by the contours? The grid theme of elevation probably gave you the clue already. It is a mountain. In fact, it is a volcano.

If you like, label the contour lines.

Step 7 Close the project

Close the project without saving any changes.

You have completed this exercise

Create hillshades

Hillshaded relief maps are perhaps the most valuable tool in displaying a surface. Without the shading effect, it can be difficult to visualize the behavior of the surface. In this exercise, you will create hillshades using the Compute Hillshade option from the Surface menu and experiment with different sun azimuth values.

If you have not downloaded the exercise data for this module, you should download the data now.

Step 1 Start ArcView

Start ArcView and load the Spatial Analyst extension.

Note: If you are running ArcView GIS 3.1, you see a Welcome to ArcView GIS dialog. Click Cancel to close this dialog.

If ArcView is already running, close any open projects.

Step 2 Open the project

From the File menu, choose Open Project. Navigate to the **surfalsa\lesson2**

directory and open the project **l2_ex02.apr**.

Note: If you are running ArcView GIS 3.1, you see an Update l2_ex02.apr message box. Click No to dismiss this box.

When the project opens, you see an Elevation view containing an Elevation grid theme.

VIEW RESULT

You can derive some information about the surface from the view, like the location of canyons in the mountainous area to the north, but for the most part, the details of the surface are hidden.

Step 3 Create a hillshade grid with the sun in the northwest

Now you'll create a hillshade grid from the elevation grid theme.

Make the Elevation theme active. From the Surface menu, choose Compute Hillshade.

The Compute Hillshade dialog opens. Notice that the default azimuth (315) and altitude (45) place the sun in the upper left quadrant. This is because people expect to see shadows on the bottom of objects. If you put the sun in the south where it really belongs, most people will perceive the mountains as being valleys.

Click OK to accept the default azimuth and altitude settings.

When the Hillshade of Elevation grid theme appears, make it active, choose Properties from the Theme menu, and rename the new grid to **Hillshade315**.

Turn on the Hillshade315 grid theme.

VIEW RESULT

As you see, it is much easier to interpret a hillshade of a surface.

In the next step, you will create a hillshade with the sun in the southeast to see what happens.

REVIEW CONCEPT

Step 4 Create a hillshade grid with the sun in the southeast

Again, you'll create a hillshade grid from the Elevation grid theme. This time, you'll use an azimuth of 135 and an altitude of 45. This combination puts the sun in the lower right quadrant.

Make the Elevation theme active. From the Surface menu, choose Compute Hillshade. This time, **135** for the azimuth and **45** for the altitude. Click OK.

When the Hillshade of Elevation grid theme appears, make it active, choose Properties from the Theme menu, and rename the new grid to **Hillshade135**. Turn on the Hillshade135 grid theme. Turn off Hillshade315.

VIEW RESULT

Do you see how the surface appears to have been inverted? The United States Geological Survey (USGS) suggests that hillshades created for cartographic purposes should always have the sun located in the northwest. You may have to

experiment with the azimuth and angle settings, especially if the surface has valleys and ridges that trend along a northwest/southeast line, in which case, few shadows are created and the 3D effect is lost.

Hillshading has analytic uses, as well. The values that it returns (0 to 255) are, of course, gray values, but they may also be interpreted as an index of sun exposure, where low values (black) get little sunlight and high values (white) get a lot. This information is useful in agricultural suitability models, vegetation classification, and so forth.

In the next step, you'll see how a hillshade grid can be used to enhance visualization of another grid theme.

Step 5 Create a color hillshaded relief grid

By using a hillshade as a brightness theme, you can create a color hillshade where the colors are based on an attribute, such as land use or elevation. That is, a yellow band of elevation will be bright on the sunny side of a mountain and darker on the shaded side of the mountain.

Turn off the Hillshade135 theme. The Elevation theme should be turned on.

Double-click on Elevation to open the Legend Editor. Click the Advanced button.

The Advanced Options dialog box opens.

In the Brightness Theme dropdown list, choose Hillshade315. Keep the default values for Minimum Cell Brightness and Maximum Cell Brightness. Click OK.

In the Legend Editor, choose Elevation #1 in the Color Ramp dropdown list. Click Apply, then close the Legend Editor.

Do you see how it is easier to visualize topography with the hillshaded grid used as a brightness theme for the Elevation grid?

VIEW RESULT

Step 6 Close the project

Close the project without saving any changes.

You have completed this exercise

Summary

In this lesson, you learned how to visualize surface data by creating contours and hillshades.

Isolines are lines connecting points of equal value. Contours are isolines of elevation. The contour interval is the change in z value between contour lines. The base contour is a starting point from which contours go above and below based on the contour interval.

Hillshading computes surface illumination and is very useful for visualizing surface relief. A hillshaded grid can be created either by using the Compute Hillshade option on the Surface menu or by using the Hillshade request. The Hillshade request allows you to specify the z value to use. A hillshade can enhance the relief of a surface when it's used as a brightness theme

This is the **Introduction to Surface Analysis with ArcView Spatial Analyst - Lesson 2 Self test**.

Please watch your time—you have 2 hours to complete this test.

Use the knowledge you have gained in *Introduction to Surface Analysis with ArcView Spatial Analyst* to answer the following questions. You will need to correctly answer 7 of the following questions to pass.

Netscape Users: Do not resize this browser window. This can cause the page to reload and generate new questions.

GOOD LUCK!

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1. Lines connecting equal duration of sunshine are called:

- Isogonics
- Isotherms
- Isohyets
- Isohels

2. The Advanced button of the Legend Editor may be used to specify a hillshade theme as a brightness for the display of another grid theme.

- True
- False

3. The default sun position used by Compute Hillshade has an altitude of 45 degrees with an azimuth of 315 degrees.

- True
- False

4. The base contour is the minimum contour.

- True
- False

5. The Hillshade request uses a default Z factor of 2 if Nil is entered.

- True
- False

6. If you need to exaggerate the z values while hillshading to enhance the relief of an elevation surface, what should you do?

- Use an azimuth between 90 and 180 degrees
- Use an azimuth between 180 and 270 degrees
- Specify a Z factor higher than 1
- Use an altitude greater than 45 degrees

7. The Contour Line tool creates one contour line connecting all other locations with the same value as the selected location.

- True
- False

8. Hillshading is a visualization tool that computes surface illumination as values from 0 – 100 based on light source angle and elevation.

- True
- False

9. If the base contour is set to 300 and the interval is set to 75, which of the following represent valid contour values?

- -5,-80,-155,-230
- -5375, -5450, -5525, -5600
- -5425, -5500, -5575, -5650
- -5475, -5550, -5625, -5700

10. Selecting Create Contour from the Surface menu creates a line shapefile from a point feature theme and a line grid theme from a continuous surface.

- True
- False