

A digital elevation model (DEM) is a digital file consisting of terrain elevations. It is a raster (grid) representation of a continuous surface where each cell value in the raster represents elevation. Patterns that are not readily apparent in the DEM can be derived from it such as contours, slope, aspect [steepest downslope direction], hillshade [shaded relief] and viewshed [line of sight].

To get accurate results from surface analysis, you must make sure that the data has been projected. If the data has a geographic coordinate system but no projected coordinate system, use the *Project Raster* tool to project the data to an appropriate projected coordinate system.

To use Surface Analysis Tools you first need to activate the Spatial Analyst Extension.

1. Select **Customize** from the main menu and **Extensions** from the secondary menu. Select **Spatial Analyst**.

Creating Contours from a DEM:

Contours can be useful for finding areas of the same value. You may be interested in obtaining elevation values for specific locations and examining the overall gradation of the land.

1. Open **ArcToolbox**. Expand **Spatial Analyst Tools > Surface > double-click on Contour**.
2. For **Input raster**, select the DEM from the drop-down box.
3. For **Output polyline features**, **Browse** to where you would like to save the output and give it a meaningful name.
4. For **Contour interval**, type the desired distance between contours in map units.
5. Type a **Base contour** from which to start contouring, or leave the default of 0.
6. Optionally, type a value for the **Z-factor**.
7. Click **OK**.

Creating a Hillshade from a DEM:

The Hillshade tool obtains the hypothetical illumination of a surface by determining illumination values for each cell in a raster. It does this by setting a position for a hypothetical light source and calculating the illumination values of each cell in relation to neighbouring cells. It can greatly enhance the visualization of a surface for analysis or graphical display, especially when using transparency.

1. In **ArcToolbox**, expand **Spatial Analyst Tools > Surface > double-click on Hillshade**.
2. For **Input raster**, select the DEM from the drop-down box.
3. For **Output raster**, **Browse** to where you would like to save the output and give it a meaningful name.

4. For the **Azimuth** value, accept the default. [The default is 315 degrees.] (Alternatively you can specify the azimuth value you want to use.)
5. For the **Altitude** value, accept the default. [The default is 45 degrees.] (Alternatively you can specify the value you want to use.)
6. Optionally, check **Model shadows**. [By checking this option, those cells that will be in the shadow of another cell will be identified. Cells that are in the shadow of another cell are coded 0; all other cells are coded with integers from 1 to 255. By leaving this option unchecked (the default), the local illumination is calculated whether the cell falls in a shadow or not.]
7. Accept the default **Z factor** of 1 if the map units are in metres and the z value is also in metres. Specify a z factor if your z units are in a different unit of measure than your x y units. [e.g. if your x and y map units are in kilometres and your z units are in meters you would specify a Z factor of 0.001][Z units are multiplied by the z-factor specified to convert the z units to the same unit of measure as the x,y units.]
8. Click **OK**.

Creating Slope from a DEM:

The Slope tool calculates the maximum rate of change between each cell and its neighbours, for example, the steepest downhill descent for the cell (the maximum change in elevation over the distance between the cell and its eight neighbours). Every cell in the output raster has a slope value. The lower the slope value, the flatter the terrain; the higher the slope value, the steeper the terrain. The output slope raster can be calculated as percent of slope or degree of slope.

1. In **ArcToolbox**, expand **Spatial Analyst Tools > Surface > double-click on Slope**.
2. For **Input raster**, select the DEM from the drop-down box.
3. For **Output raster**, **Browse** to where you would like to save the output and give it a meaningful name.
4. Choose the **Output measurement** units.
5. Specify a z-factor if your z units are in a different unit of measure than your x,y units. Z units are multiplied by the z factor specified to convert the z units to the same unit of measure as the x y units. [If x y units are kilometres and z units are metres specify the z units as 0.001 [1km/1000m = 0.001km/m]
6. Click **OK**.

Creating Aspect from a DEM:

Aspect identifies the steepest downslope direction from each cell to its neighbours. It can be thought of as slope direction or the compass direction a hill faces.

Aspect is measured clockwise in degrees from 0, due north, to 360, again due north, coming full circle. The value of each cell in an aspect dataset indicates the direction the cell's slope faces. Flat areas having no downslope direction are given a value of -1.

With the Aspect tool, you can find all north-facing slopes on a mountain as part of a search for the best slopes for ski runs or find all southerly slopes in a region to identify locations where the snow is likely to melt first to identify those residential locations likely to be hit by runoff first.

1. In **ArcToolbox**, expand **Spatial Analyst Tools > Surface > double-click on Aspect**.
2. For **Input raster**, select the DEM from the drop-down box.
3. For **Output raster**, **Browse** to where you would like to save the output and give it a meaningful name.
4. Click OK.

Creating Viewshed from a DEM:

Viewshed identifies the cells in an input raster that can be seen from one or more observation points or lines. If you have only one observer point, each cell that can see that observer point is given a value of one. All cells that cannot see the observer point are given a value of zero. The observer points feature class can contain points or lines.

Viewshed is useful when you want to know how visible objects might be—for example, How much of the landscape will be visible from fire monitoring towers? Or what will the view be from this road?

1. In **ArcToolbox**, expand **Spatial Analyst Tools > Surface > double-click on Viewshed**.
2. For **Input raster**, select the DEM from the drop-down box.
3. For **Input point or polyline observer features**, select the feature layer to use as observer points.
4. For **Output raster**, **Browse** to where you would like to save the output and give it a meaningful name.
5. Specify a z-factor if your z units are in a different unit of measure than your x,y units.
6. Click OK.