Processing DEMs with the ArcSIE extension

Background

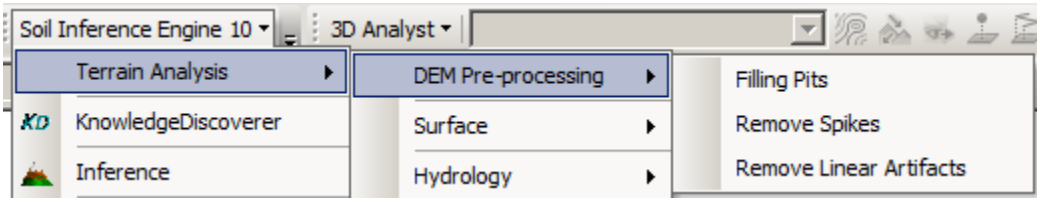
This job aid is to inform users of the availability of the ArcSIE Extension and provide a brief overview of unique features and a link to the User Guide. The ArcSIE software is free and CCE certified for USDA use.

ArcGIS is the GIS software of choice for USDA-NRCS. There has been a licensing agreement in place since 2002 that covers much of the ESRI product line for many USDA agencies, including NRCS. Use of the software for conservation, engineering, and soil survey applications is well established across the Agency. ArcGIS has limitations regarding the development of terrain derivatives. Some of these limitations have been overcome by the ArcSIE software extension that operates within the familiar ArcGIS framework.

ArcSIE is primarily used as a knowledge-based reasoning tool for soil mapping activities. It also provides the capability for processing DEMs and development of terrain derivatives using parameters unavailable with standard ArcGIS software. The ability to specify size and shape of a neighborhood, independent of raster resolution, is a significant enhancement available with the ArcSIE extension. Please refer to the ArcSIE User Guide (AUG) for more detailed information (available at: http://www.arcsie.com/Download.htm).

Preprocessing DEM Tools

Note: Refer to Chapter 3, Terrain Analysis, in AUG.

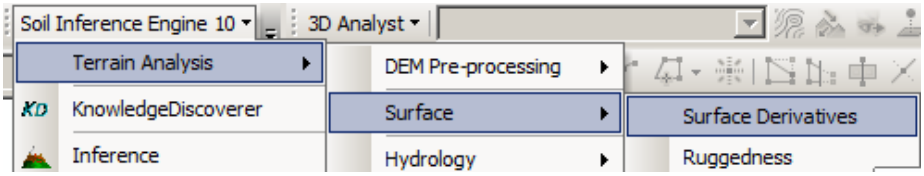


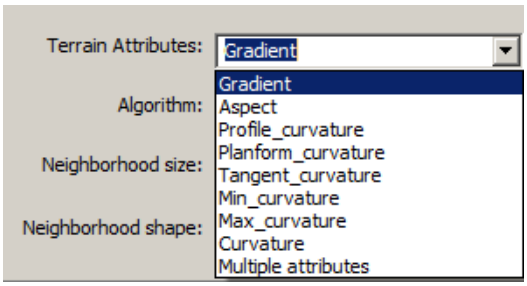
Filling Pits. This tool is analogous to the Fill command in ArcGIS.

Remove Spikes. This tool provides the option of removing artifacts or vegetative spikes automatically or with a specified shapefile of spike locations. The user may also confine the removal to areas below a specified elevation. There is no directly available tool in ArcGIS for this operation.

Remove Linear Artifacts. This tool is designed to remove the linear “bumps” of roads from elevation data. A shapefile of the linear features is required as an input. There is no directly available tool in ArcGIS for this operation.

Developing Terrain Derivatives





Processes Available in ArcSIE and Not in ArcGIS

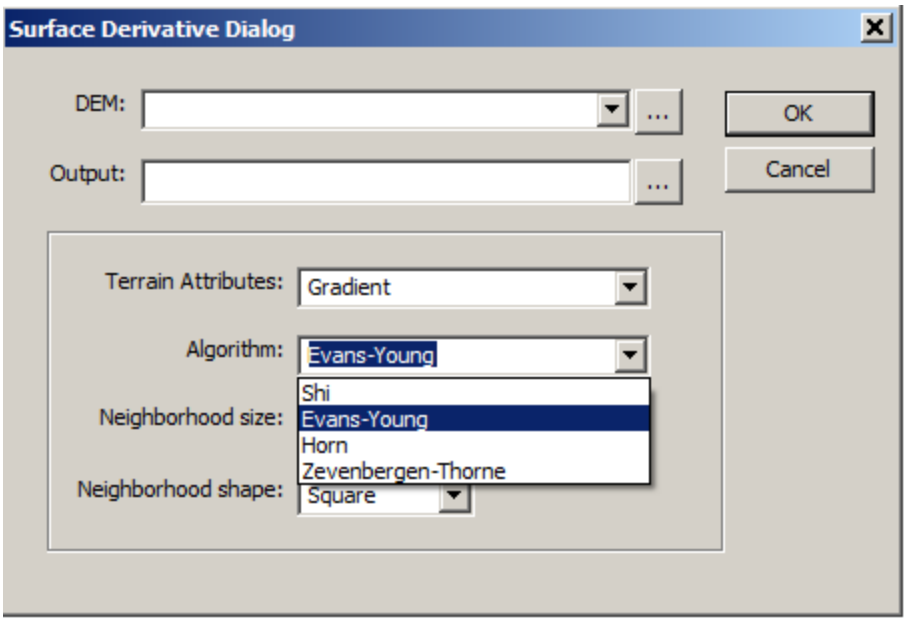
- Tangent Curvature
- Minimum Curvature
- Maximum Curvature
- Multiple attributes (batch process selected set of available derivatives)

Available Parameters

Note: There is a job aid on resolution and neighborhoods that provides additional explanations for these parameters.

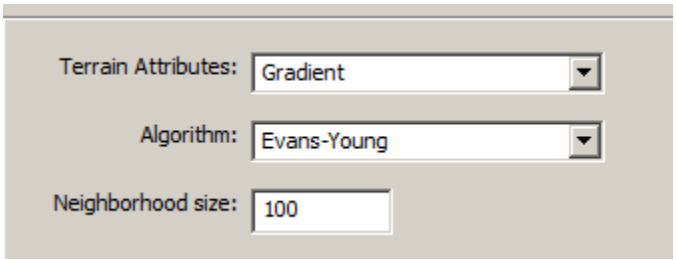
Interpolation Algorithms. Four are provided (some are grouped in one):

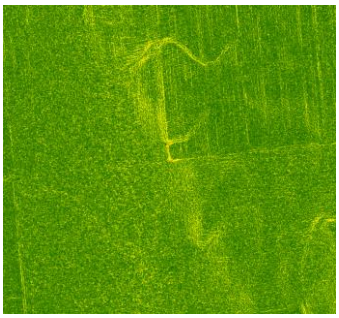
- Preferred method for noisy DEMs
- Evans-Young or Horn
- Preferred method for smooth DEMs
- Shi or Zevenbergen-Thorne



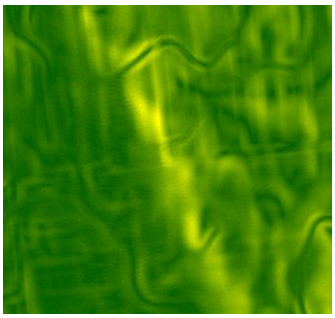
ArcGIS uses the Evans-Young algorithm exclusively.

Neighborhood Size. Any size may be specified for the calculation neighborhood. The neighborhood size is not dependent on the cell resolution of the DEM. Neighborhood size is a critical parameter to control when using high-resolution data. ArcGIS restricts its neighborhood to the traditional 3 x 3 window, resulting in noisy output when using high-resolution data.



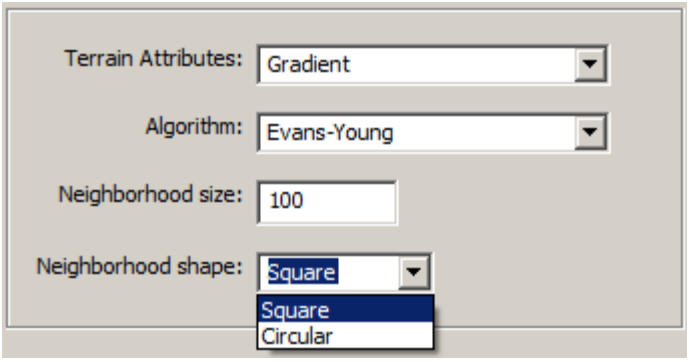


Above: Slope from ArcGIS.



Above: Slope from ArcSIE with 100' neighborhood.

Neighborhood Shape. Both square and circular neighborhoods are supported.



Research suggests that circular neighborhoods are more accurate than square neighborhoods (Shi et al., 2007; Shi et al., 2012; Smith et al., 2006).

ArcGIS is confined to a 3 x 3 window.

Additional Derivatives

Ruggedness. This tool implements the topographic ruggedness index (TRI) developed by Riley et al. (1999). TRI is the rooted mean squared difference between the elevation of a cell and the elevations of the cells in its neighborhood. The same routine is available in SAGA and the xTerrain Toolbox.

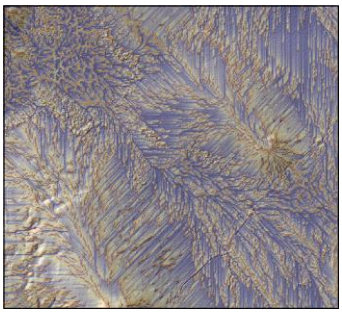
Flow Accumulation. This tool determines the upslope contributing area for each cell and assigns this area to the value of the cell. The unit assigned is the same as the horizontal units of the layer, e.g., square feet or square meters. This differs from ArcGIS, which assigns a cell count to the value of the cell.

Both uni-path and multipath flow paths are supported. The uni-path algorithm assumes water flows only to one of the cells in the eight cardinal directions. The multipath algorithm routes water to all neighboring cells of a lower elevation, using the Quinn et al. (1991) algorithm. The algorithm in ArGIS is confined to uni-path.

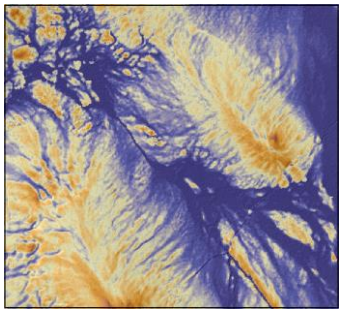
Wetness Index. This is also known as Compound Topographic Index and Topographic Wetness Index and is calculated as:

w = ln(Flow Accumulation/Slope Gradient)

The uni-path, multipath, and multipath smoothed flow path algorithms are supported. The multipath algorithm overcomes the unnatural patterns typical with the uni-path output. The multipath smoothed algorithm helps to overcome the “dry valley” problem common in broad, flat flood plains.



Above: Wetness index implemented with ArcGIS Unipath.



Above: Multipath wetness index with ArcSIE.

Ridgeline. This tool identifies cells that occupy ridgetops.

Broad – Narrow Ridgeline. This tool differentiates broad and narrow ridges.

Topographic Classification. This tool implements the method developed by Iwahashi and Pike (2007) for characterizing terrain. The method uses slope gradient, local convexity, and surface texture with a set of rules to dissect the mapping area into a user-specified number of classes (8, 12, or 16).

Zimmerman's Relative Position. This tool is based on an algorithm by Zimmermann (1999) and generates continuous measurements of relative slope positions, from ridgetop or peak to valley bottom. It runs at various spatial scales and then hierarchically integrates the results at different scales into a single layer.

Streamlines. This tool derives streamlines from a DEM. The user can select one of three methods: (1) O'Callahan and Mark, (2) Skidmore, or (3) Peuker and Douglas. The preferred method is O'Callahan and Mark. An option to order streams according to the following methods—Simple, Shreve, Strahler, Unique—is also available.

References

Iwahashi, J., and R.J. Pike. 2007. Automated classifications of topography from DEMs by an unsupervised nested-means algorithm and a three-part geometric signature. Geomorphology 86:409–440.

Quinn, P.F., K.J. Beven, P. Chevallier, and O. Planchon. 1991. The prediction of hillslope flowpaths for distributed modelling using digital terrain models. Hydrological Processes 5:59-80.

Riley, S.J., S.D. DeGloria, and R. Elliott. 1999. A terrain ruggedness index that quantifies topographic heterogeneity. Intermountain Journal of Science 5:23-27.

Shi, X., A-X. Zhu, J. Burt, W. Choi, R-X. Wang, T. Pei, and B-L. Li. 2007. An experiment with circular neighborhood in the calculation of slope gradient from DEM. Photogrammetric Engineering and Remote Sensing 73(2):143-154.

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Smith, M. P., A. Zhu, J.E. Burt, and C. Stiles. 2006. The effects of DEM resolution and neighborhood size on digital soil survey. Geoderma 137(1):58-69.

Zimmerman, N. 1999. http://www.wsl.ch/staff/niklaus.zimmermann/programs/aml4_1.html