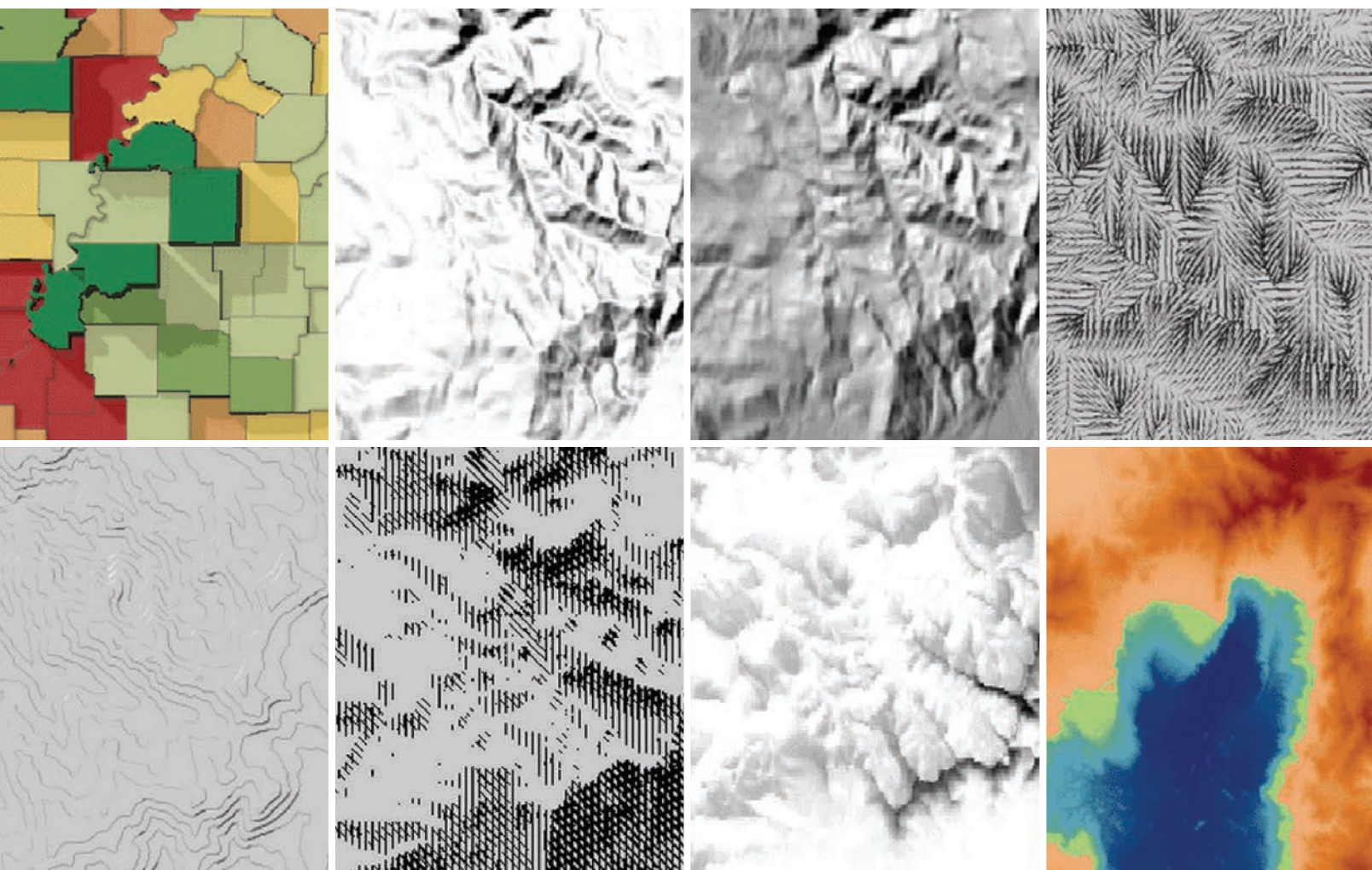
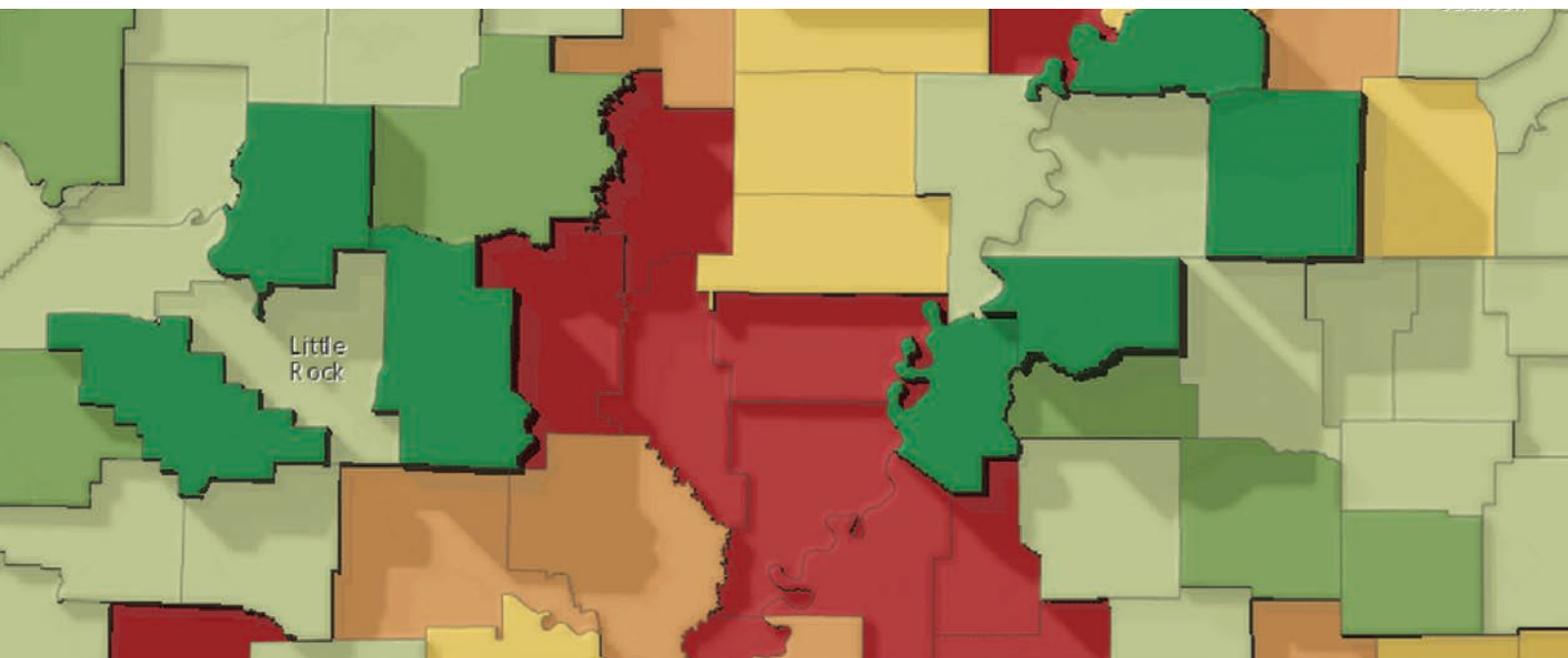


# TAKE YOUR TERRAIN MAPPING TO NEW HEIGHTS

By Kenneth Field, Senior Cartographic Product Engineer



↓ The 3D Choropleth tool adds depth to a choropleth map by encoding a second piece of information or as a way of showing variation within a single class interval.



Standard techniques for representing terrain, like a hillshade, are adequate for many applications, but you may want to represent terrain under different lighting conditions or perhaps use more artistic techniques. In these cases, you might need to go a little further than creating a simple hillshade. For this reason (and because we like making tools that extend what we can do!), Esri built a new toolbox called Terrain Tools that helps you take your terrain mapping to new heights.

Cartographic research often develops techniques, models, and tools that supplement or extend what you find in software out of the box. They are often difficult to find, may be hidden in journal articles, or are cumbersome to implement.

We've brought together some of these ideas and workflows in the Terrain Tools toolbox, which provides capabilities for creating alternative terrain representations in both ArcMap and ArcGIS Pro. Terrain Tools encourage you to be more creative by extending your out-of-the-box toolkit for representing terrain in GIS. They will help you think more critically about design choices and how to go beyond the defaults.

You can download Terrain Tools Sample, a ZIP file that contains the toolbox, sample data, documentation, an ArcMap map document, and an ArcGIS Pro project from ArcGIS Online. The map document and ArcGIS Pro project also include results layers so you can see how the tools work before you use them on your own data.

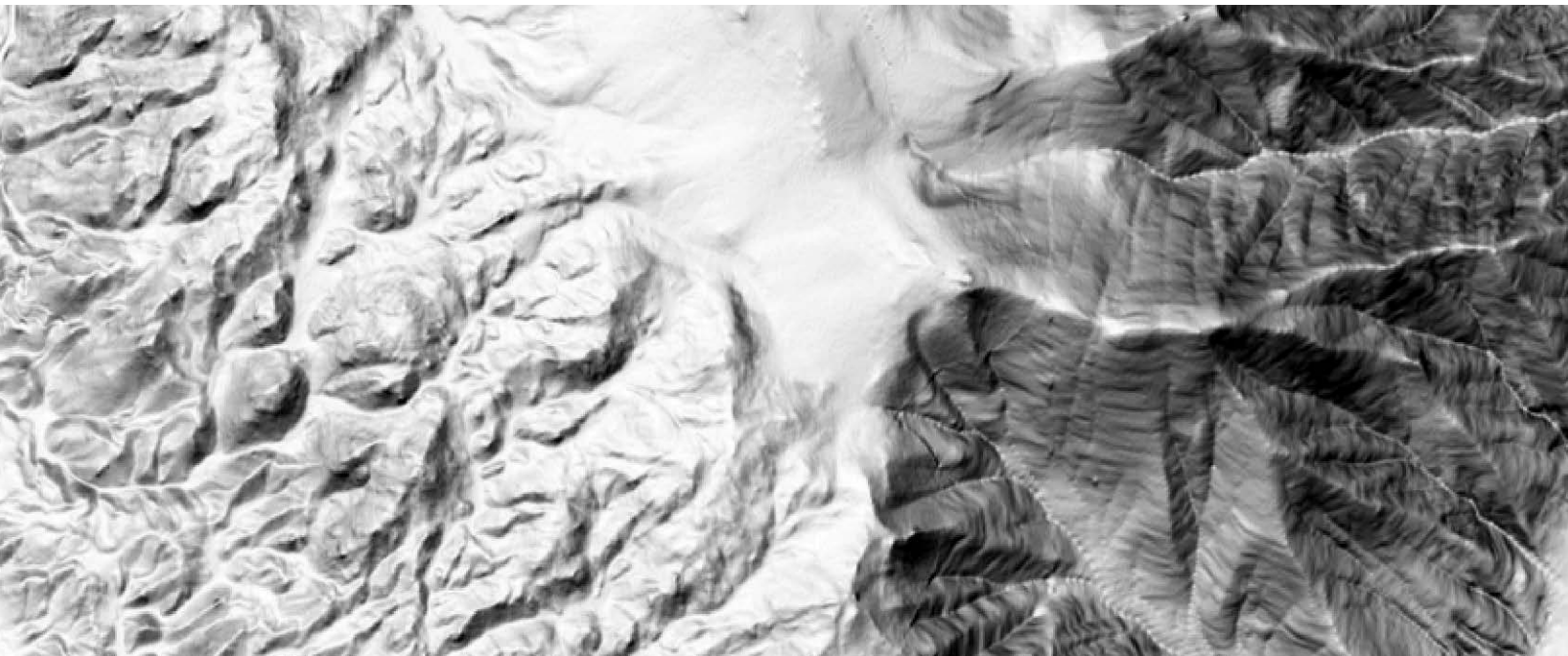
It's important to note that the sample results use the default output. They are a starting point. Many of the tools give you the flexibility to modify parameters and customize your own output. The documentation is in workshop format that includes a discussion of each tool and instructions for use. Because the tools are written in Python, they can be viewed, modified, and used as a starting point for further development.

The Terrain Tools Sample incorporates a few previously available tools originally built as models using ModelBuilder that have been rewritten and optimized as Python scripts, which improves their stability and processing speed. In addition, new tools have been either written from the original published algorithms or optimized as Python scripts from code samples.

One of the highlights of Terrain Tools is the new Cluster Hillshade, which provides you with the ability to make spectacularly detailed and artistic hillshades with your



↓ Cluster Hillshade produces spectacularly detailed and artistic hillshades.



Multi-Directional Oblique Weighted (MDOW) Hillshade	Produces a hillshade that emphasizes oblique illumination on all surfaces by using more than one illumination azimuth
Swiss Hillshade	Builds and then combines several hillshades resulting in a yellow-blue Swiss hillshade effect
Cluster Hillshades	A suite of three tools that uses k-means clustering to create a seamless change of local lighting conditions throughout the generation of a hillshade to produce stunning results
Sky Models	Builds multiple hillshades with varying azimuth, zenith, and intensity of light source and combines them in a weighted output to create hillshades under different lighting conditions with some dramatic effects
Historic Dots	Creates and symbolizes contours using a historic dotted line symbol and modifies the overall appearance by removing contours for low slope angles
Filled Contours	Creates and symbolizes nested polygons such that the boundary lines demarcate areas of equal elevation value
Illuminated Contours	An analytical version of the Tanaka method of symbolizing contours that includes coloring and varying the thickness of illuminated and nonilluminated contour lines
Hachures	Creates an output that illustrates three-dimensional topography on a two-dimensional map using hachures that symbolize slope and aspect
Shadow Lines	An artistic drawing method in which lines of variable thickness and orientation approximate tonal variations associated with shading and shadowing
Chromastereoscopic Tinting	A technique that encodes depth values by color and which, when viewed through glasses that contain minute prisms, gives a holographic 3D view of the data (Glasses are not included.)
3D Choropleth	Breathes life into the choropleth mapping technique by building multiple hillshades that emphasize differences across the statistical surface

↑ Table 1: Tools in the Terrain Tools Sample

↓ The results of applying the Illuminated Contours and Filled Contours tools, which both use the Tanaka method.



own data. This is just about as close as you can get with an automated process to classic hand-drawn hillshading—and all from just a digital elevation model (DEM) input and a mouse click. One tool lets you use the Tanaka method for creating illuminated contours and filled contours.

Thematic maps haven't been ignored. It's perfectly possible to run the tools for any input raster (e.g., a statistical surface rather than a DEM), but there's also a specific 3D Choropleth tool that is useful for adding depth to a choropleth map by encoding a second piece of information or as a way to see variation within a single class interval.

There are plenty of tools to explore. The scripts are entirely open to being customized further. Table 1 lists what is included in the Terrain Tools sample.

We're indebted to a number of key researchers who assisted in the development of these tools. You'll find references and links to their original work in the

documentation and the tool help.

Get the Terrain Tools Sample 1.0 beta from ArcGIS Online. Enjoy using these tools whether you're looking for a more advanced hillshade or something a little more artistic. Use them as a starting point for inspiration and share your efforts!

### About the Author

**Dr. Kenneth Field** is a self-confessed cartonerd. After 20 years in academia, he now works at Esri in cartographic research and development for the mapping systems team. He writes, teaches, and blogs about map design; is editor of *The Cartographic Journal*, and is on the advisory board of the *International Journal of Cartography*. He is the chairperson of the ICA Map Design Commission, a fellow of both the British Cartographic Society and Royal Geographic Society, and a Chartered Geographer (GIS). You can follow him on Twitter @kennethfield or check his blog.



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