Calculating Landscape Shape with Lat/Long DEMs

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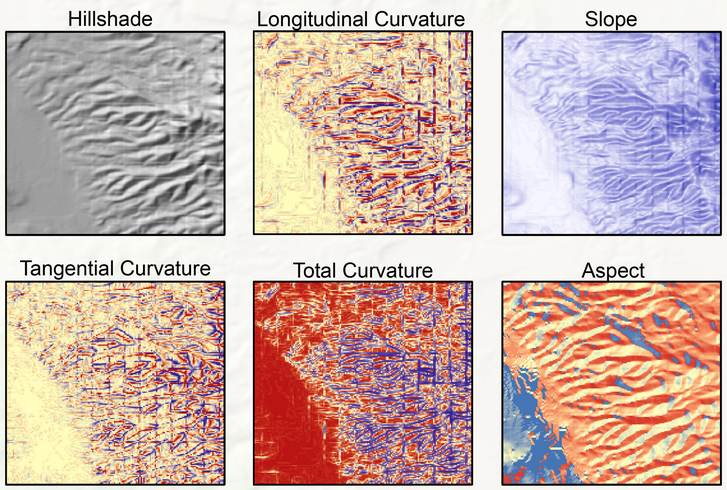
These functions are available in the ArcGIS extension "DEM Surface Tools"
All formulae and references are described in full in the manual
Available for free download at http://www.jennessent.com/arcgis/surface_area.htm

The Problem

Existing ArcGIS Surface tools do not work well with data in a geographic (i.e. Latitude / Longitude) coordinate system. They expect the vertical units of a Digital Elevation Model (DEM) to be the same as the horizontal units, and at best they only allow you to set an adjustment factor (the "Z-factor") to adjust the Z-units to your X/Y-units. This Z-factor adjustment method cannot be accurately used with lat/long coordinate systems because the Z-units are linear and the X/Y units are angular. Even worse, the true distance of a degree in latitude changes with latitude while a degree in Longitude is fairly constant.

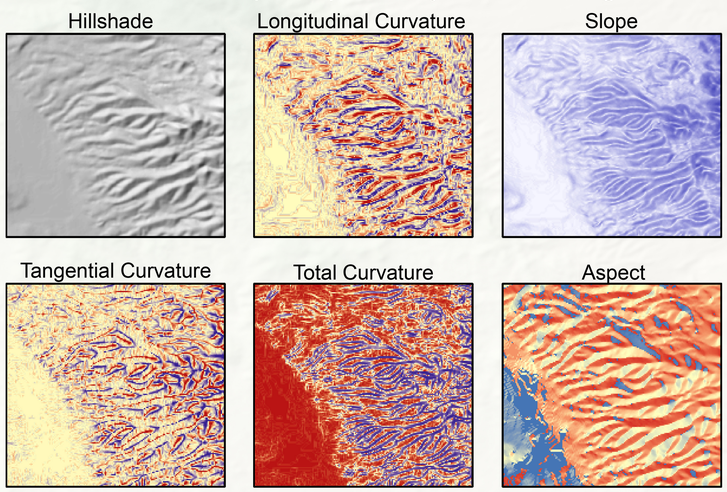
Unfortunately, most free elevation data available online is only available in latitude / longitude coordinates. This data can be projected, but projecting raster data introduces significant errors in resolution and precision:

Calculated from Projected DEM
Notice horizontal and vertical artifacts



The Goal

Calculate landscape shape directly from Lat / Long DEM

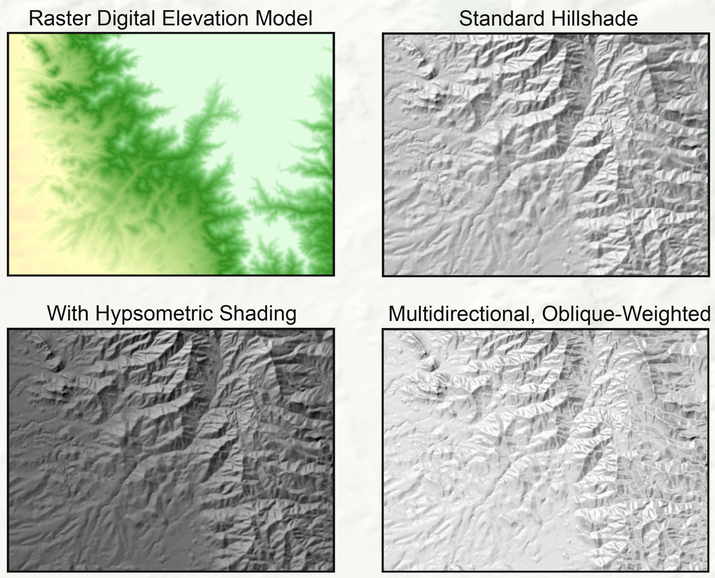


The Solution

This extension rewrites the algorithms for landscape shape so that **all functions work directly with Latitude/Longitude data**, thus saving time and disk space and preserving the original DEM accuracy. As a bonus, this extension offers several options not available in the basic ArcGIS Surface tools.

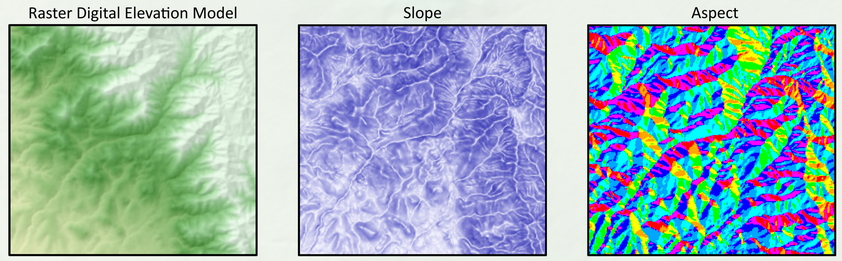
Hillshades

Few methods are as intuitive and easy to understand as a hillshade. A good hillshade tells you immediately what areas are ravines, ridges, peaks or valleys.



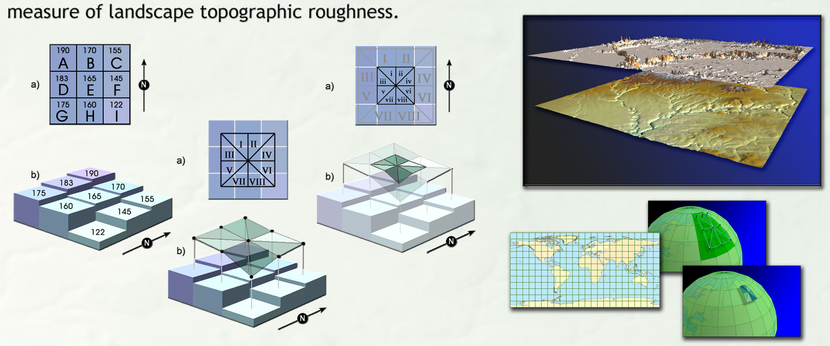
Slope and Aspect

The slope of the landscape affects where structures or trails can be built, crops can be planted or harvested, the speed of flowing water and consequent erosion, landslide potential, and the list just goes on and on. Aspect is an important contributor to vegetation and habitat type and is important in determining whether significant features are visible from a particular point on the landscape.

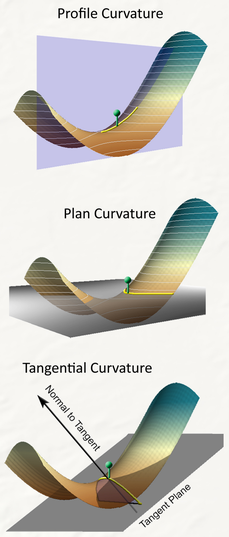


Surface Areas and Ratios

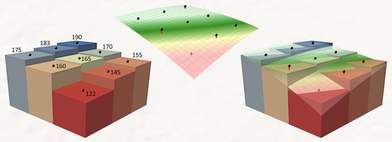
Surface area tells you the true area available in a region, and also serves as a basis for a useful measure of landscape topographic roughness.



Landscape Curvature



Landscape curvature is often used in analysis of streamflow and topographic ruggedness. In most cases, landscape curvature is defined as the curvature of the line of intersection between the landscape surface and some mathematical plane. Curvature based on a plane that is either horizontal or tangential to the landscape surface tells us whether water will converge or diverge as it flows over the point. A vertical plane pointed in the aspect direction tells us whether water will speed up or slow down.



Curvature values are derived from a 3-dimensional polynomial curve fitted to the 9 elevation points. This extension uses a 6-parameter polynomial to model the surface (see manual for details).

$$z = \frac{rx^2}{2} + \frac{ty^2}{2} + sxy + px + qy + u$$