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Shadows Eclipse Relief Shading

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Abstract:

Cartographers tout the merits of relief shading in giving terrain a three-dimensional appearance, while tending to ignore or discourage the use of shadowing for the shadow's tendency to obscure the underlying topographic details. It is possible, however, to discard relief shading and use only shadows from multiple light sources to create shadowing effects that have similar landform details and with the potential for a more dramatic three-dimensional effect when compared to relief shading. We present comparisons of a standard elevation model illuminated by a clear sky with a) relief shading, b) shadows, and c) relief shading plus shadows in Figure 1.

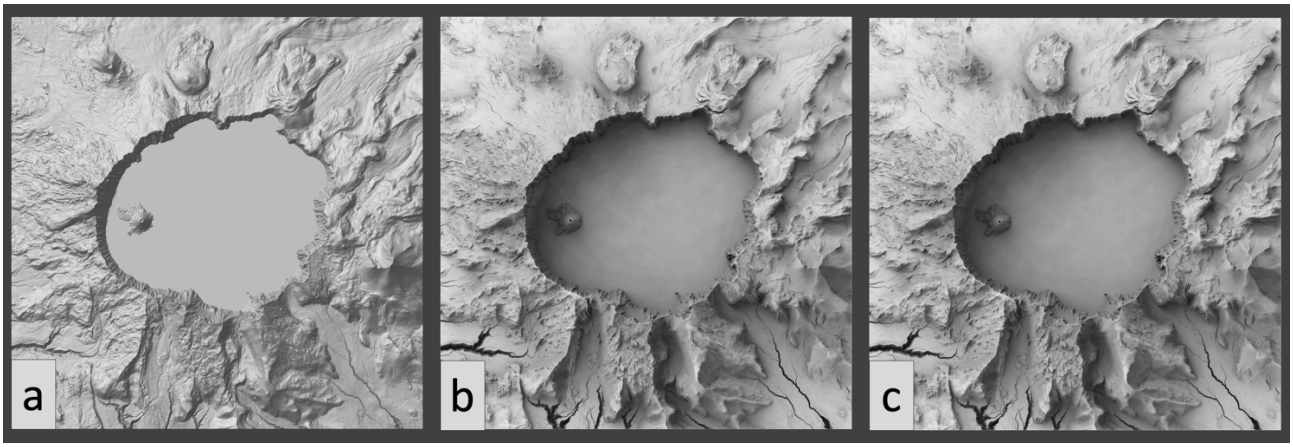

Figure 1. A comparison of a) relief shading b) shadows and c) relief shading plus shadows for the standard elevation model of Crater Lake, Oregon USA illuminated by a clear sky.

We observe that adding relief shading to a shadowed rendering (Figure 1c) does not add much topographic detail to the shadow-based terrain representation (Figure1b). This may seem non-intuitive, as terrain is being represented not by the orientation of the land's surface with respect to a light source which is the basis of relief shading, but rather by the shadows cast by landforms that are aligned with the illumination direction. This result underscores the importance of illumination models that represent numerous point sources throughout the sky to simulate natural lighting conditions and result in soft shadows.

Another important comparison between relief shading and representing terrain with shadows is that vertical exaggeration of the elevation model can produce more dramatic effects with the latter, as seen in the top row of Figure 2. This enhanced effect can be attributed to longer shadows with vertically exaggerated terrain. By contrast, vertical exaggeration of terrain for relief shading as seen in the bottom row of Figure 2 may make illuminated areas lighter and non-illuminated areas darker in grayness, but general patterns of lighter and darker areas remain the same while undergoing tonal modulations. These patterns are locked into place by the static nature of landform locations as opposed to the dynamic nature of their shadows' extents.

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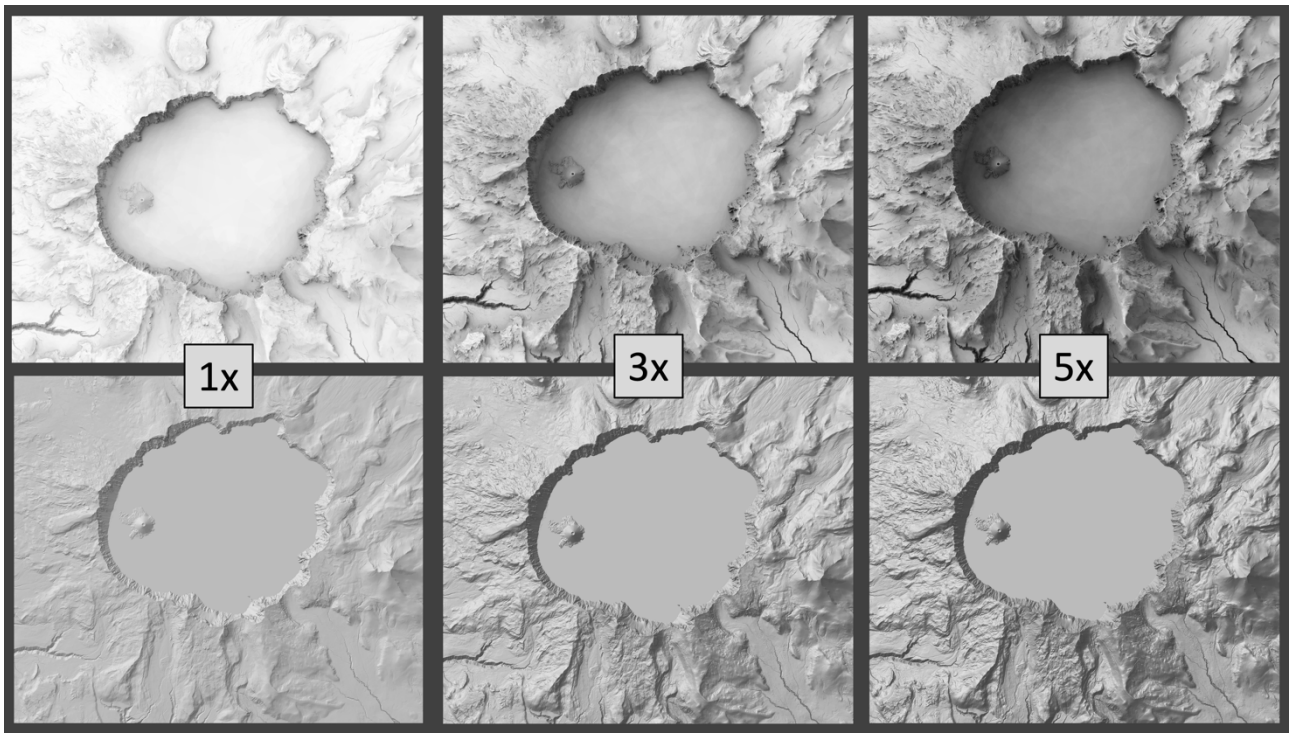

Figure 2. A comparison of shadowing (top row) with relief shading (bottom row) using vertical exaggeration values of 1x, 3x, and 5x of the standard elevation model of Crater Lake, Oregon USA illuminated with a clear sky.

Shadowing terrain from multiple directions, once a cumbersome task, is simplified with our new tool. The technique casts individual shadows using a method inspired by Ware's (1989) “shadowline” method, updated and optimized to take advantage of the Python programing environment's handling of array data. We can calculate shadows row-by-row rather than cell-by-cell, as is done with other shadow-casting methods. Once cast, a weighted sum of individual shadows results in the final map.

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