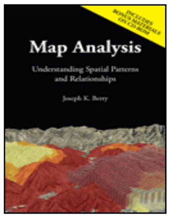
Beyond Mapping III



Map Analysis book

Topic 5 – Calculating Visual Exposure (Further Reading)

Use Maps to Assess Visual Vulnerability — *discusses a procedure for identifying visually vulnerable areas (February 2003)*

Try Vulnerability Maps to Visualize Aesthetics — *describes a procedure for deriving an aesthetics map based on visual exposure to pretty and ugly places (March 2003)*

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Use Maps to Assess Visual Vulnerability

(GeoWorld, Febbruary 2003)

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Previous discussion in Topic 5 introduced fundamental concepts and procedures used in visual analysis. As a quick review, recall that the algorithm uses a series of expanding rings to determine relative elevation differences from the viewer position to all other map locations. Elevation differences that are less than those in previous rings are not seen.

The top portion of figure 1 illustrates the procedure. The ratio of the elevation difference (*rise* indicated as striped boxes) to the distance away (*run* indicated as the dotted line) is used to determine visual connectivity. Whenever the ratio exceeds the previous ratio, the location is marked as seen (red); when it fails it is marked as not seen (grey).

To conceptualize the procedure, imagine a searchlight illuminating portions of a landscape. As the searchlight revolves about a viewer location the lit areas identify visually connected locations. Shadowed areas identify locations that cannot be seen from the viewer (nor can they see the viewer). The result is a ***viewshed map*** as shown draped over the elevation surface in figure 1. Additional considerations, such as tree canopy, viewer height and view angle/distance, provide a more complete rendering of visual connectivity.

The top portion of figure 2 shows the viewsheds from three different viewer locations. Each map identifies the locations within the project area that are visually connected to the specified viewer location. Note that there appears to be considerable overlap among the "seen" (red) areas on the three maps. Also note that most of the right side of the project area isn't seen from any of the locations (grey).

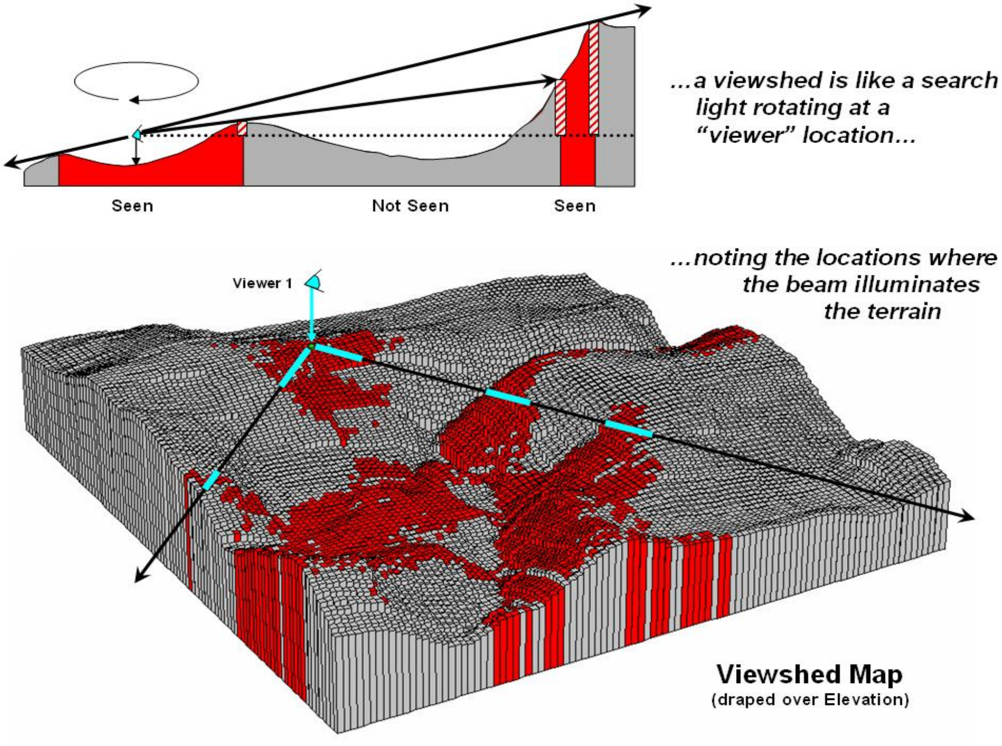

Figure 1. Calculating a viewshed.

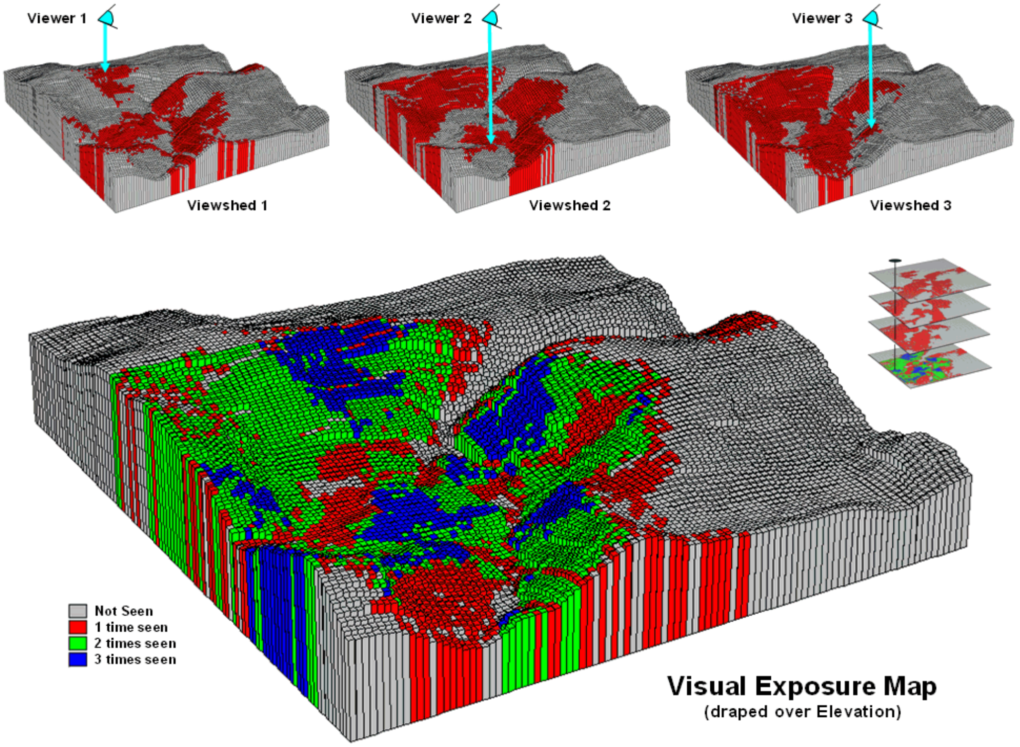

Figure 2. Calculating a visual exposure map.

A ***visual exposure*** map is generated by noting the number of times each location is seen from a set of viewer locations. I n figure 2 this process is illustrated by adding the three viewshed maps together. The resulting visual exposure map in the bottom of the figure contains four values—0= not seen, 1= one time seen, 2= two times seen and 3= three times seen—forming a relative exposure scale.

The top portion of figure 3 shows the result considering the entire road network as a set of viewer locations. In addition, the different road types are weighted by the number of cars per hour. In this instance the total "number of cars" replaces the "number of times seen" for each location in the project area.

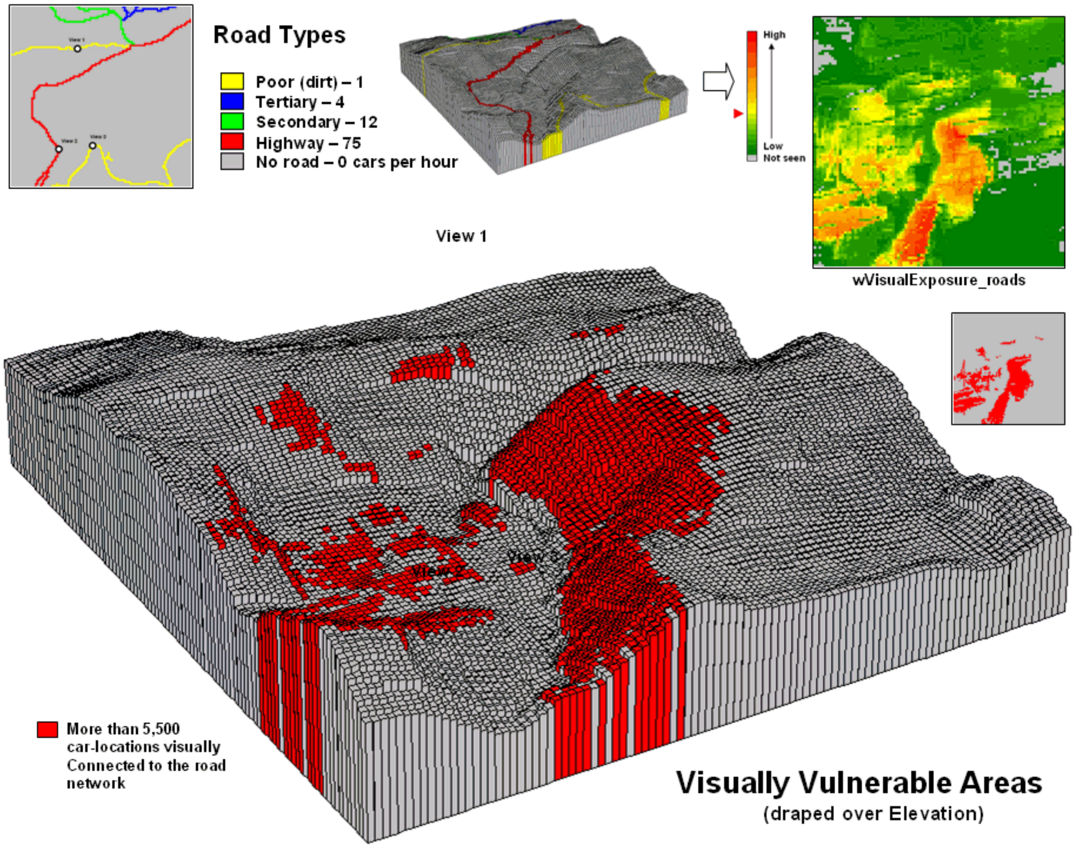

Figure 3. Calculating a visual vulnerability map.

The effect is that extra importance is given to road types having more cars yielding a ***weighted visual exposure map***. The relative scale extends from 0 (not seen; grey) to 1 (one car-location visually connected; dark green) through 12,614 (lots and lots of visual exposure to cars; dark red). In turn, this map was reclassified to identify areas with high visual exposure—greater than 5,500 car-locations (yellow through red)—for a map of ***visual vulnerability***.

A visual vulnerability map can be useful in planning and decision-making. To a resource planner it identifies areas that certain development alternative could be a big "eyesore." To a backcountry developer it identifies areas whose views are dominated by roads and likely a poor choice for "serenity acres." Before visual analysis procedures were developed, visceral visions of visual connectivity were conjured-up with knitted-brows focused on topographic maps tacked to a wall. Now detailed visual vulnerability assessments are just a couple of clicks away.

Try Vulnerability Maps to Visualize Aesthetics

(GeoWorld, March 2003)

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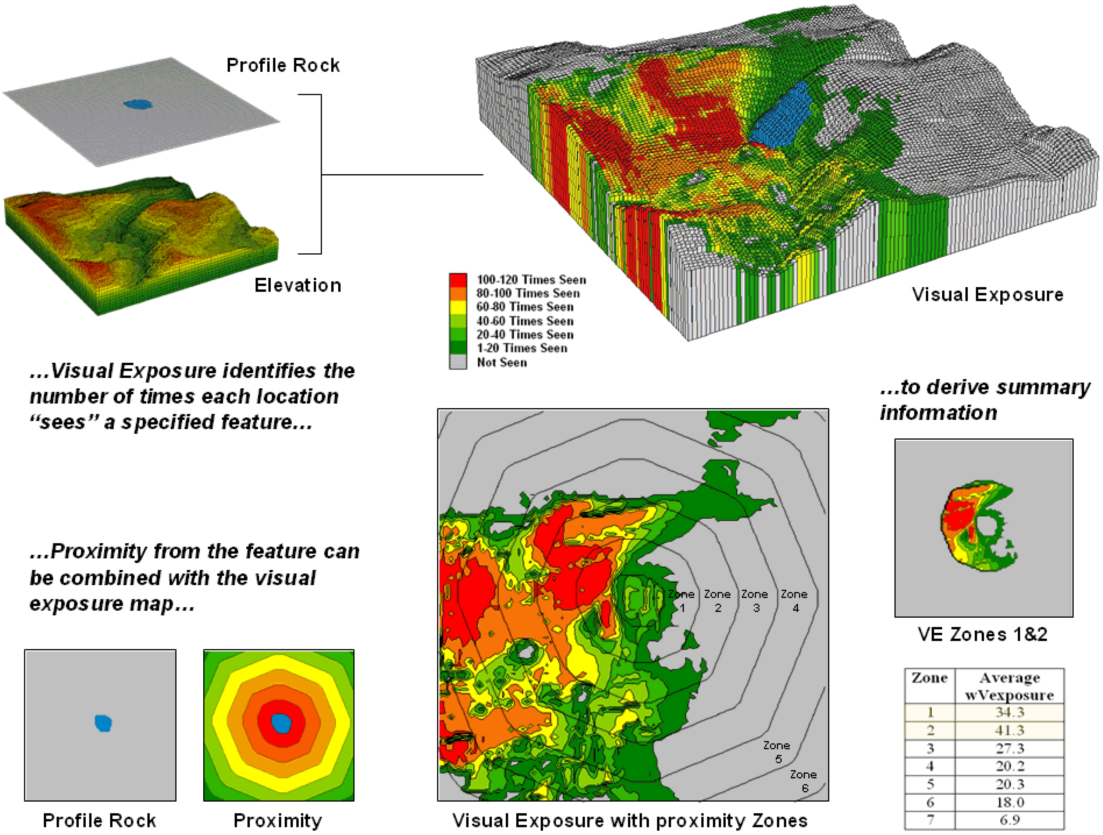
The previous section described procedures for characterizing ***visual vulnerability***. The approach identified "sensitive viewer locations" then calculated the relative visual exposure to the feature for all other locations in a project area. In a sense, a feature such as a highway is treated as an elongated eyeball similar to a fly's compound eye composed of a series of small lenses—each grid cell being analogous to a single lens.



…Visual Exposure identifies the number of times each location "sees" a specified feature…

…Proximity from the feature can be combined with the visual exposure map…

…to derive summary information

Zone	Average wVexposure
1	34.3
2	41.3
3	27.3
4	20.2
5	20.3
6	18.0
7	6.9

Figure 1. Visual connectivity to a map feature (Profile Rock) identifies the number of times each location sees the extended feature.

In figure 1, Profile Rock is composed of 120 grid cells positioned in the center of the project area. In determining visual exposure to Profile Rock, the computer calculates straight line connectivity from one of its cells to all other locations based on its relative position on the elevation surface. Depending on the unique configuration of the terrain some areas are marked as seen and others are not.

The process is repeated for all of the cells defining Profile Rock and a running count of the "number of times seen" is kept for each map location. The top right inset displays the resulting visual exposure from not seen (VE= 0; grey) to the entire feature being visible (VE= 120; red). As you might suspect, a large amount of the opposing hillside has a great view of Profile Rock. The southeast plateau, on the other hand, doesn't even know it exists.

The lower portion of figure 1 extends on the concept of visual exposure by introducing distance. It is common sense that something near you (foreground) has more visual impact than something way off in the distance (background). A proximity map from the viewer feature is generated and distance zones can be intersected with the visual exposure map (lower-right inset in figure 3). The small map on the extreme right shows visual exposure for just distance Zones 1 and 2 (600m reach). The accompanying table summarizes the average visual exposure to Profile Rock within each distance zone—much higher for Zones 1 and 2 (34.3 and 41.3) than the more distant zones (27.3 or less).

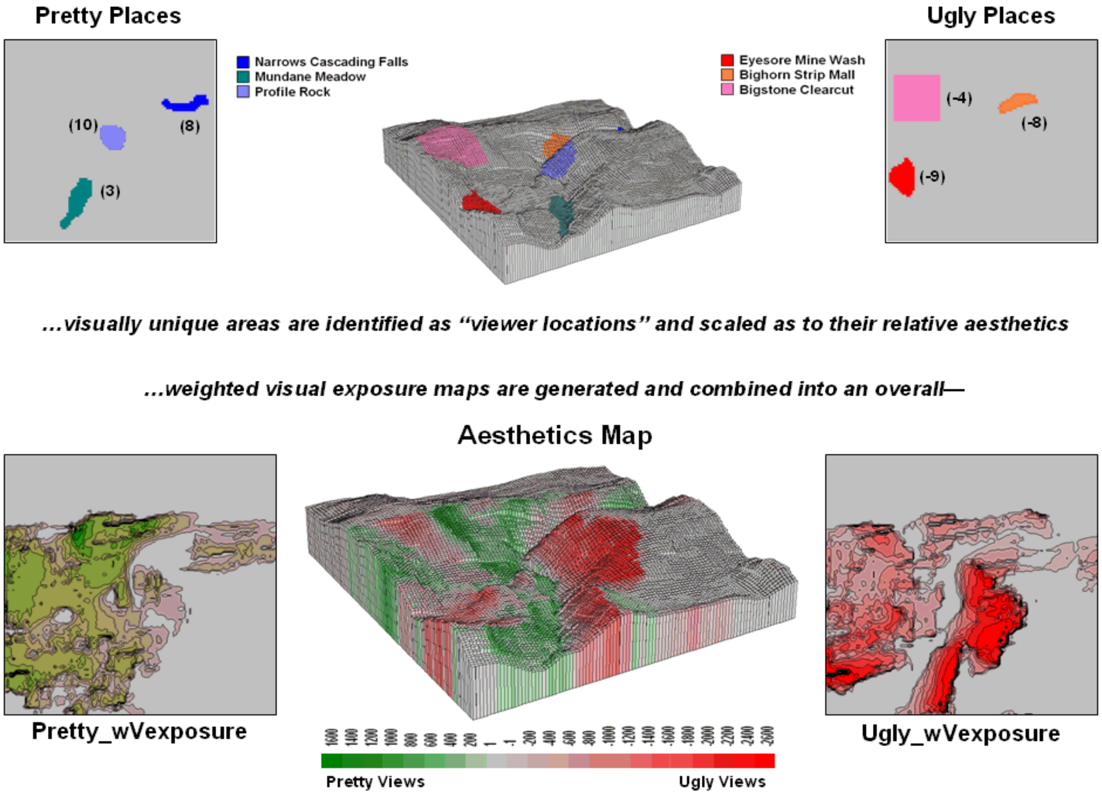


Figure 2. An aesthetic map determines the relative attractiveness of views from a location by considering the weighted visual exposure to pretty and ugly places.

The ability to establish weighted visual exposure for features is critical in deriving an ***aesthetic map***. In this application various features are scaled in terms of their relative beauty— 0 to 10 for increasing pretty places and 0 to -10 for increasing ugly places. For example, Profile Rock represents a most strikingly beautiful natural scene and therefore is assigned a “10.” However, Eyesore Mine wash is one of the ugliest places to behold so it is assigned a “-9.” In calculating weighted visual exposure, the aesthetic value at a viewer location is added to each location within its viewshed. The result is high positive values for locations that are connected to a lot of very pretty places; high negative values for connections to a lot very ugly places; zero, or neutral, if not connected to any pretty or ugly places or they cancel out.

The top portion of figure 2 shows the aesthetics ratings for several “pretty and ugly” features in the area as 2D plots then as draped on the terrain surface. The 2D plots in the bottom portion of the figure identify the total weighted visual exposure for connections from each map location to pretty and ugly places.

The overall aesthetic map in the center is analogous to calculating net profit—revenue (think Pretty) minus expenses (think Ugly). It reports the net aesthetics of any location in the project area by simply adding the *Pretty_wExposure* and *Ugly_wExposure* maps. Areas with negative values (reds) have more ugly things within their view than pretty ones and are likely poor places for a scenic trail. Positive locations (greens), on the other hand, are locations where most folks would prefer to hike.

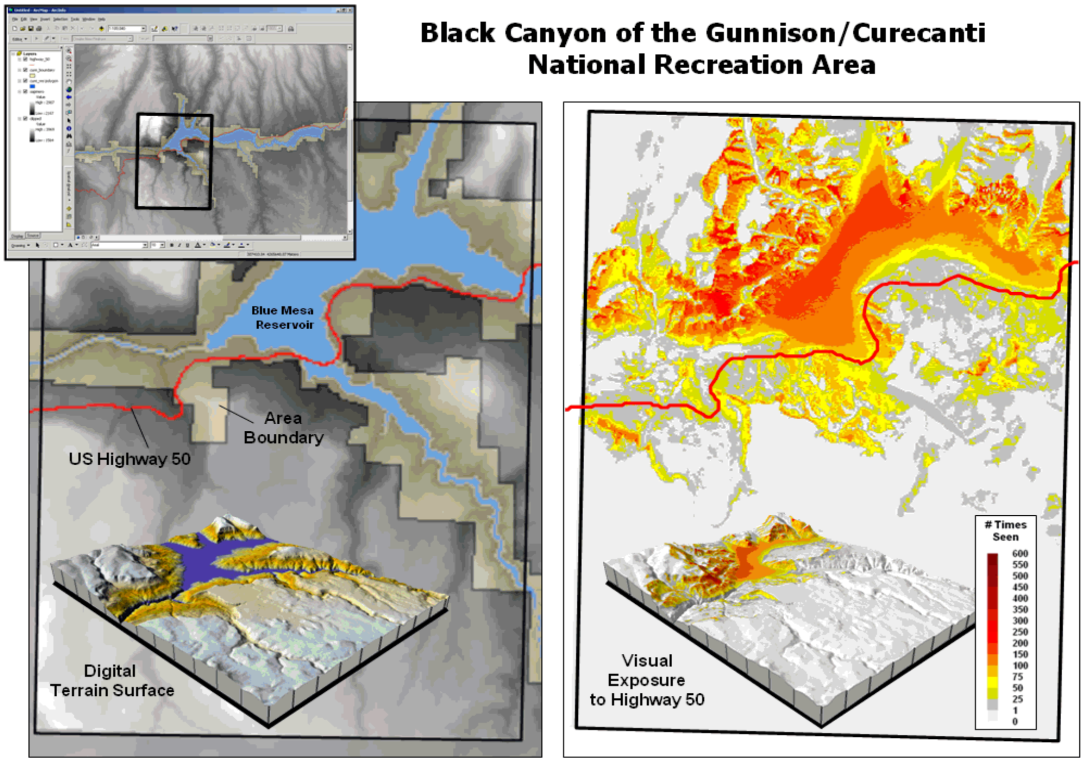


Figure 3. Weighted visual exposure map for an ongoing visual assessment in a national recreation area.

Real-world applications of visual assessment are taking hold. For example, a senior honors thesis project is underway at the University of Denver by a student intern with the National Park Service (see author's note). The project will develop visual vulnerability maps from the reservoir in the center of the park and a major highway running through the park (right side of the figure 3). In addition, aesthetic maps will be generated based on visual exposure to pretty and ugly places in the park.

It seems to be a win-win situation with the student getting practical GIS experience (not to mention a lot of awesome hiking for field verification) and NPS will get cutting-edge procedures and maps they need for effective resource planning. My guess is that there is a university near you that is looking for "a few good clients" to take GIS education beyond the classroom—give them a call.

Author's Note*: Senior Honors Thesis by University of Denver Geography student Chris Martin, 2003.*

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