Abstract

Title: Visibility Analysis of Tumalo Mountain Hiking Trail
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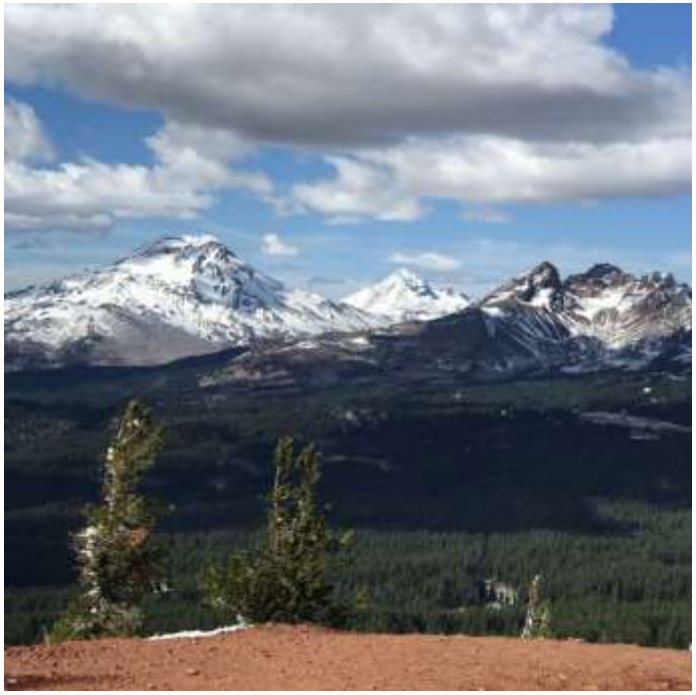
I have performed a GIS terrain analysis where I examine a scenic hiking trail named Tumalo Mountain Trail located near Bend, Oregon in the Deschutes National Forest where I specifically look at its visibility of prominent Cascade mountain peaks within the nearby area of the national forest. Based on Tumalo Mountain Trail's popularity for being one of the best liked hiking trails within Deschutes National Forest, its geographic location near prominent Cascade mountain peaks, and scenic pictures of mountains, Tumalo Mountain Trail is a very scenic hiking trail in terms of mountain views, and is a trail that very intrigued me to examine its visibility. In order to test the visibility of mountains from the trail, I need to reference mountain peak points along with two additional mountain peak base points for each mountain that I construct based upon terrain data. My specific research question is how many mountain points constructed and referenced within my GIS analysis are viewable from Tumalo Mountain Trail? The problem within this analysis is that the elevation data I use to determine visibility is bare ground elevation data that excludes above ground heights such as trees. In order to preserve the integrity of this analysis knowing that the trail is heavily obscured in forest, I need to use land cover data to exclude the portions of the trail covered in forest, because there is no way of knowing if the area classified as forest can see mountains relying solely on GIS data.

Visibility Analysis of Tumalo Mountain Hiking Trail

By Matthew Schindlbeck

The Trail

- Tumalo Mountain Trail: Scenic trail located near Bend, Oregon in Deschutes National Forest



Visibility Analysis

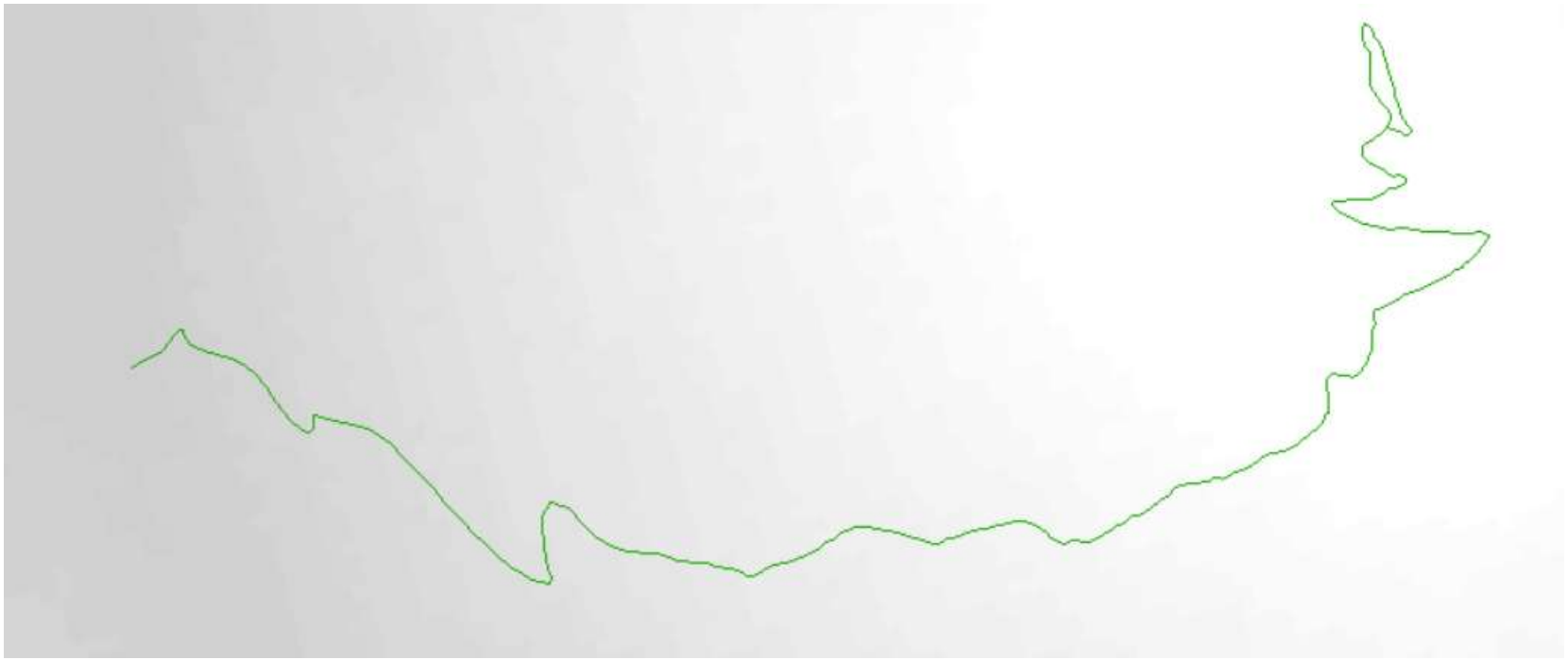
- I want to examine how many mountain views can be viewed from Tumalo Mountain Trail using GIS
- I specifically want to test visibility of viewing prominent Cascade mountains in Deschutes National Forest area
- Cascade mountains I picked for analysis: Mount Bachelor, Broken Top, South Sister, Middle Sister, North Sister, Mount Washington, Three Fingered Jack
- Based on reality: I know Tumalo can view Mount Bachelor, Broken Top, South and Middle Sister
- I want to test those mountains and other mountains that might be viewable as well performing a GIS visibility terrain Analysis

Downloaded GIS Layers

- All GIS Layers are analyzed and Projected using the PCS_NAD_1983_Lambert _Conformal_Conic using standard lines suited for the state of Oregon
- Deschutes_National_Forest_Administrative_Boundary (sourced by U.S. National Forest Service)

Downloaded Tumalo Trail

- Tumalo_Mountain_Trail (sourced by OpenStreetMap)



Downloaded Mountain Peaks

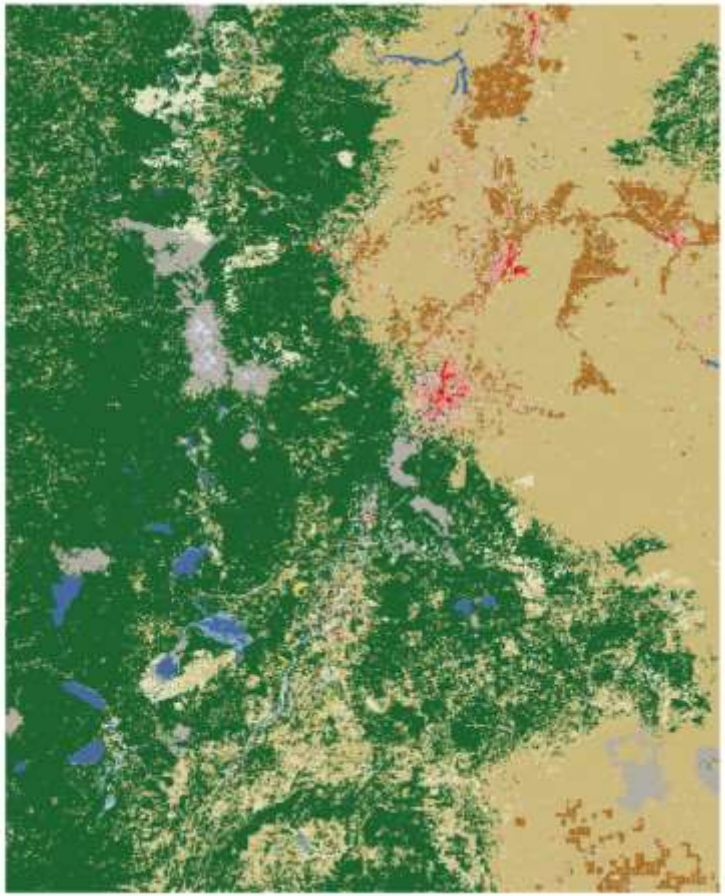
- Cascade Mountain peak and base peak points (peak points sourced by OpenStreetMap and base peak points digitized by me) – separated into two different layers: Mountains_1 and Mountains_2

Downloaded DEM

- Or_dem_clip (downloaded USGS Oregon State 30M DEM from PSU I drive) – reprojected DEM and clipped it to Deschutes National Forest boundary

Downloaded Land Cover

- nlcd_clip (2011 Oregon NLCD Land Cover raster created by USGS) – clipped raster to Deschutes National Forest boundary



Mountains

- For each of the seven mountains, I use their referenced peaks that I downloaded from OpenStreetMap and I also digitized two additional points on each mountain as their base peak points. One digitized point represents the left base and the other digitized point represents the right base of each mountain of the two base points. The reason with digitizing these peak base points is to make sure that the views of the mountain captures not only its very top peak, but captures and includes a large portion of the upper mountain and the main visual of the peak shape. If you can view a base point, the chances that you can view the upper portion of the mountain and its very top is likely. And then of course if you can see all three points of a specific mountain, then the view would be highly scenic.

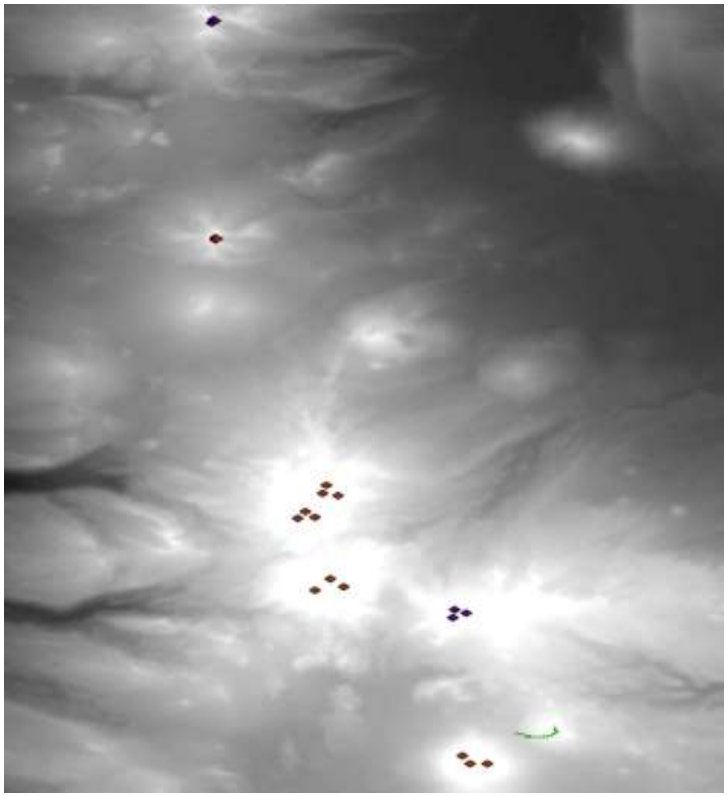
- I end up with 21 points representing mountains where each mountain has three points with a peak point, a left base point, and a right base point.

Constructing Mountains

- I construct a hillshade using the Or_dem_clip to help aide with the Or_dem_clip in determing the best place to construct the right and base points of each mountain.

Constructed Mountains

- These are the mountain points overlaid with the DEM and the trail is shown as well. It is important to note that not only did I consider the terrain of the mountains on where to digitize the points, but I had to consider the general direction of the trail and make sure that the points are on the side of the mountain facing the general direction of the trail.



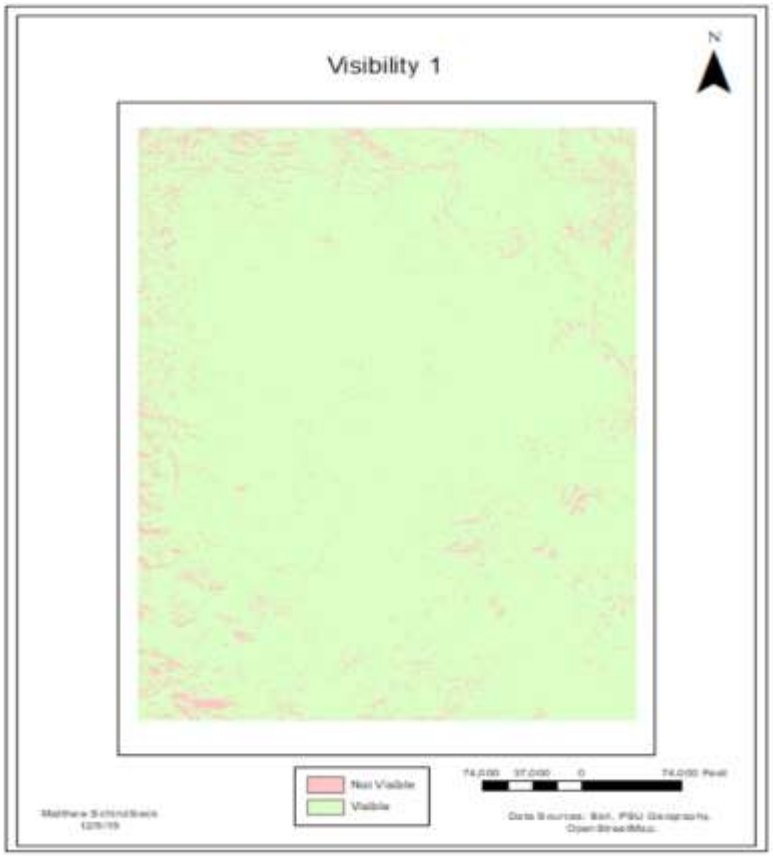
Visibility Tool

- To determine areas along the trail that view various mountain points, I used the visibility tool that produces a categorical raster surface indicating areas that can view observer points, and each value on the raster surface represents which observer points are visible. For example, the value 0 means that the area does not view any oberserver points and values 1 and greater represent combinations of which oberserver points are visible from the specified value area such as value one can only view observer 1, but value 2 can only view observer 2. A 1 value in each observer point attribute field means that the raster value area can view the point, and a 0 value means that the observer point can't be viewed by the raster value area.

- The reason why I have two mountains points feature class is because the visibility tool has a maximum of 16 features allowed, so I have Mountains_1 with 5 mountains and 15 points, and Mountains_2 with 2 mountains and 16 points. Because of this I had to run two different visibility tool sessions one using Mountains_1 and Mountains_2. I use the Or_dem_clip as the input raster and specify Observers as the Analysis type.
- Before creating the two visibility surfaces, I use the Identify tool on the DEM and add the elevation value of each point to the Attribute field Titled SPOT I created for both mountain point layers so that the Visibility tool will use those elevation values for the points and not the default bilinear method for determing the elevation of each point for performing the Visibility tool.

Visibility

- Here is what the visibility surface that Mountains_1 produced looks using the default symbology showing visible and non visible areas that view observer points. As you would imagine, there are very many different values and the pixel complexity of this surface when displaying unique values indicates so, and the surface ends up with 1242 different value combinations.



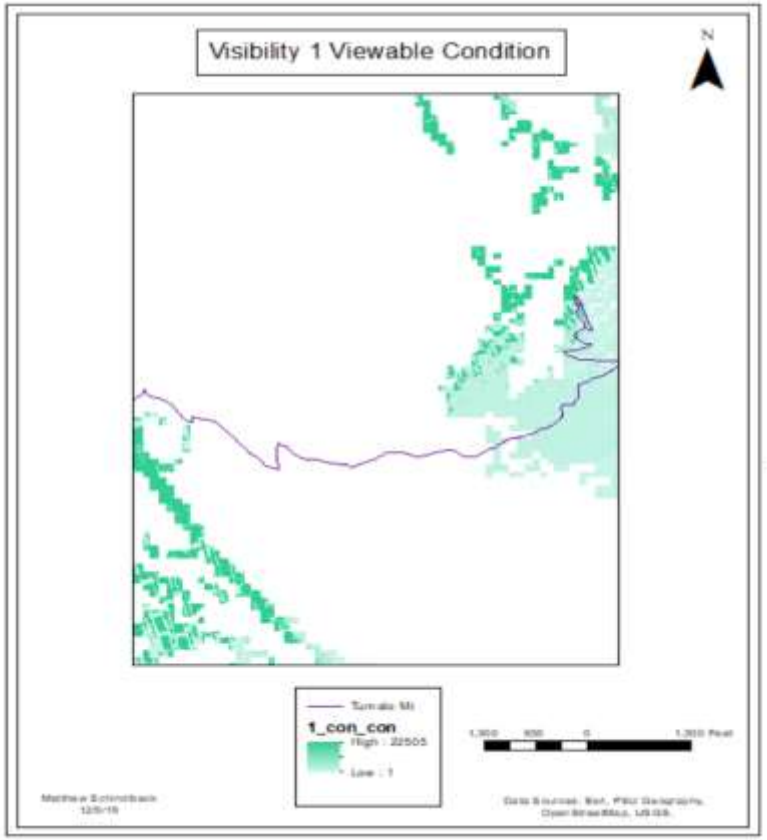
Spatial Analysis

- Once both visibility surfaces are created, I need to account for the analysis problem of the trail going through forested areas that obscure views by reclassifying the nlcd_clip so that forested land cover areas are reclassified as a 0 value (not viewable) and all other land cover values are reclassed as a 1 (viewable). After reclassifying, I need to resample the nlcd_clip so that the cell size is the same as the DEM so I can correctly perform the analysis.

- Then I use the Con tool two different times (once for visibility_1 and once for visibility_2) where I exclude all areas of the visibility surfaces with a value of 0 (forest areas)
- I then use the Con tool a second time (once for visiblity_1_Con and once for visibility_2_Con) where all areas of the visibility surfaces with only areas of viewable land cover areas exclude the value of 0 (areas where no oberserved points are viewed) on visiblity_1 and visiblity_2 surfaces.
- After this, I have created visiblity_1_Con_Con and visibility_2_Con_Con, both of these surfaces show only areas that view at least one observer point and are not covered in forest. I then can examine both surfaces by overlaying the trail and using the identify tool to record all visibility values that overlay the trail so that I can see which observer points can be viewed from the trail.

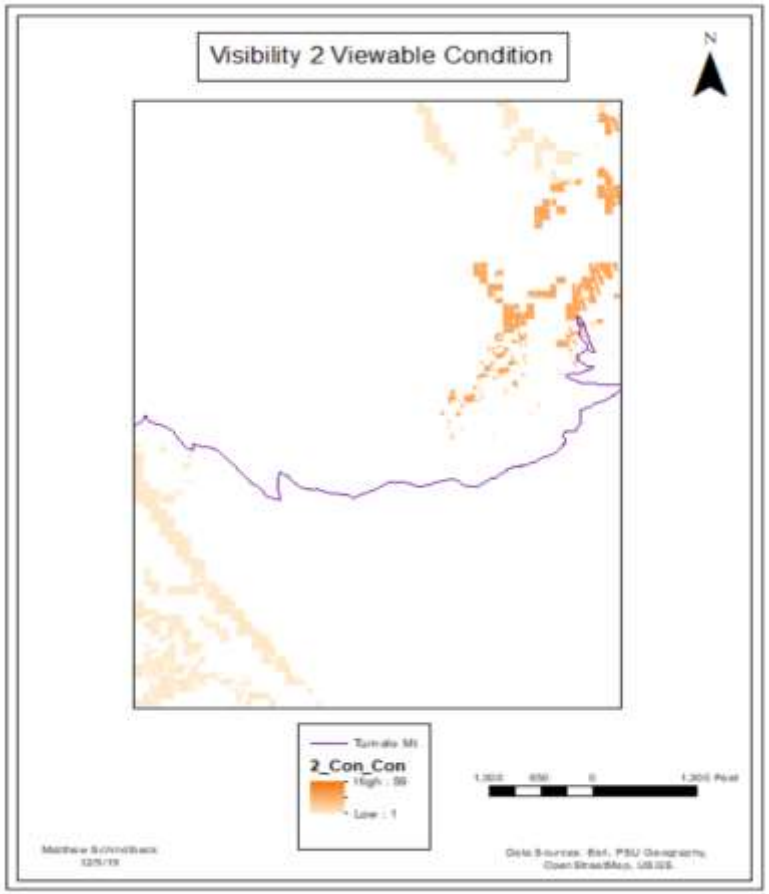
Mountains_1 Results

- Here is the final conditional surface for visibility_1 and here are the results for observer points being viewed along Tumalo Mountain Trail: Observer 1,2,3,4,5,6,7,8,10,11,13,15. That is 12 out of 15 possible points that were picked and the five mountains included in this surface are Mount Bachelor, Middle Sister, , North Sister, South Sister, and Mount Washington.



Mountains_2 Results

- Here is the final conditional surface for visibility_2 and here are the results for observer points being viewed along Tumalo Mountain Trail: Observer 2, and 6. That is 2 out of 6 possible points and the two mountains used for this surface were Broken Top and Three Fingered Jack.



Conclusion

- A total of 14 out of 21 possible mountain points are determined visible along different portions of the trail
- I am pretty pleased with the results of picking up 14 viewable points from the trail

- Improvements: I may or may not be able to pick up another point or two if I were to run this analysis again and really be very tedious and very detail oriented with where I exactly digitize my left and right base.
- This analysis and results go to show that Tumalo Mountain Trail is a very scenic hiking in terms of mountain views.