SUITABILITY ANALYSIS: BEST VIEWS IN CUYAHOGA COUNTY

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PROBLEM

Ohio sunrises and sunsets are rival the best views in Texas. Having spent many Summer and Winter Breaks with family near Cleveland, I was determined to find the best outlook in the surrounding Cuyahoga County. To achieve this goal, I created a suitability analysis by using slopes facing east or west, open areas or sparsely vegetated, and with limited views of towers (cellular towers, FM transmission towers, paging transmission) in sight. I hypothesize that the best areas for viewing sunrises or sunsets will be far from towers.

DATA COLLECTION

Data was acquired by extracting zipped files from 2 different sources- the Ohio Department of Natural Resources and Homeland Infrastructure Foundation-Level Data (Fig. 1). Sources included a digital elevation model (DEM), which is needed as the input raster for viewshed analysis, an Ohio county outline, which helped clip layers to Cuyahoga County, and different infrastructure towers, which are the "observer" location for the viewsheds. Important metadata could all be found using ArcCatalog, (Fig. 2) except for the culc94 (landcover) shapefile, in which case the landcover code meanings were found on the source website. Below is a table indicating the layer name, data type, source, spatial reference and metadata information.

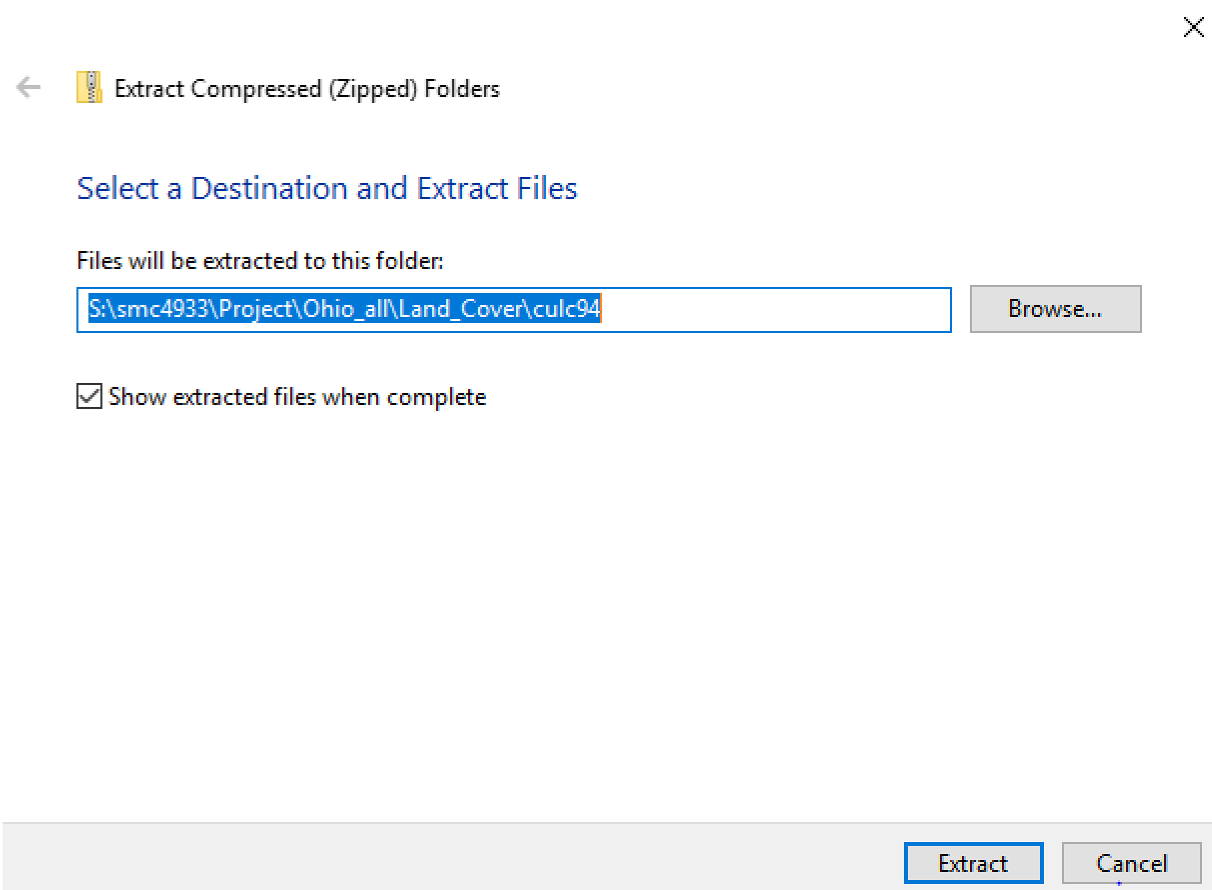

Figure 1. Extracting culc94 (landcover) data

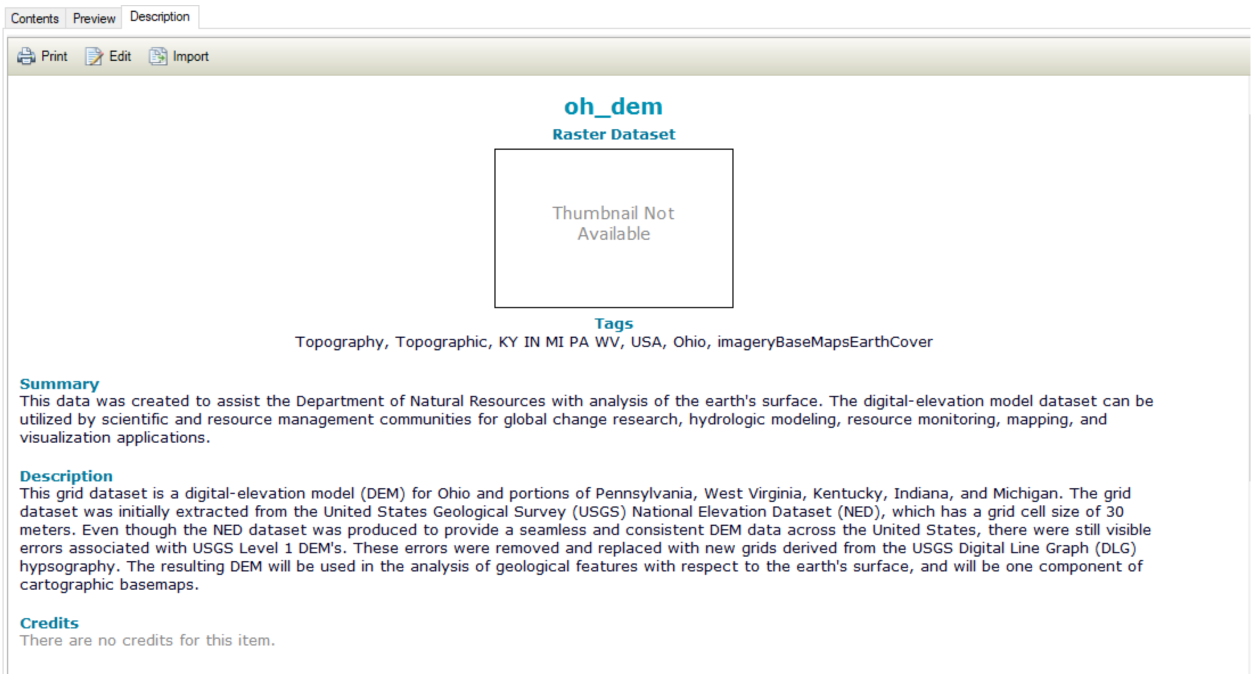

Figure 2. ArcCatalog Metadata of the DEM used

Layer Name	Data Type	Source	Spatial Reference	Metadata Info
ODNR_COUNTY	Vector – Polygon Shapefile	Ohio Department of Natural Resources	NAD 1983 State Plane Ohio South FIPS 2402 Feet	Ohio Counties
Oh_dem	Raster - DEM	Ohio Department of Natural Resources	NAD 1983 State Plane Ohio South FIPS 2402 Feet	30m digital elevation model of Ohio, in feet. Originally a NED dataset that has been updated
Culc94	Vector – Polygon Shapefile	Ohio Department of Natural Resources	NAD 1927 State Plane Ohio North FIPS 3401	Cuyahoga County Landcover, 1994
Cellular_Towers	Vector – Point shapefile	Homeland Infrastructure Foundation-Level Data	GCS WGS 1984	Tower locations in continental US
Paging_Transmission_Towers	Vector – Point Shapefile	Homeland Infrastructure Foundation-Level Data	GCS WGS 1984	Tower locations in continental US
Microwave_Service_Towers	Vector – Point Shapefile	Homeland Infrastructure Foundation-Level Data	GCS WGS 1984	Tower locations in continental US
FM_Transmission_Towers	Vector – Point Shapefile	Homeland Infrastructure Foundation-Level Data	GCS WGS 1984	Tower locations in continental US

DATA PREPROCESSING AND PROCESSING

Tower data: To narrow down the tower data to just Cuyahoga County, I opted to use the "Select by Location" tool and create a layer from there rather than clipping the shapefile to Cuyahoga County because layer files create an easier path from the source dataset and it stores symbology. The tower data far spans across the continental United States and far exceeds that of Cuyahoga County, Thus, it is projected globally. This can cause the data points to be distorted when doing analyses in a small area. Therefore, I needed to project the points to the same spatial reference. Using the "Project" tool in the Data Management toolbox, I selected NAD 1983 State Plane Ohio South FIPS 2402 Feet as the spatial reference (Fig. 3). I chose this projection because it hardly distorts Cuyahoga County. The location selection and projection of the towers was done individually for each tower type.

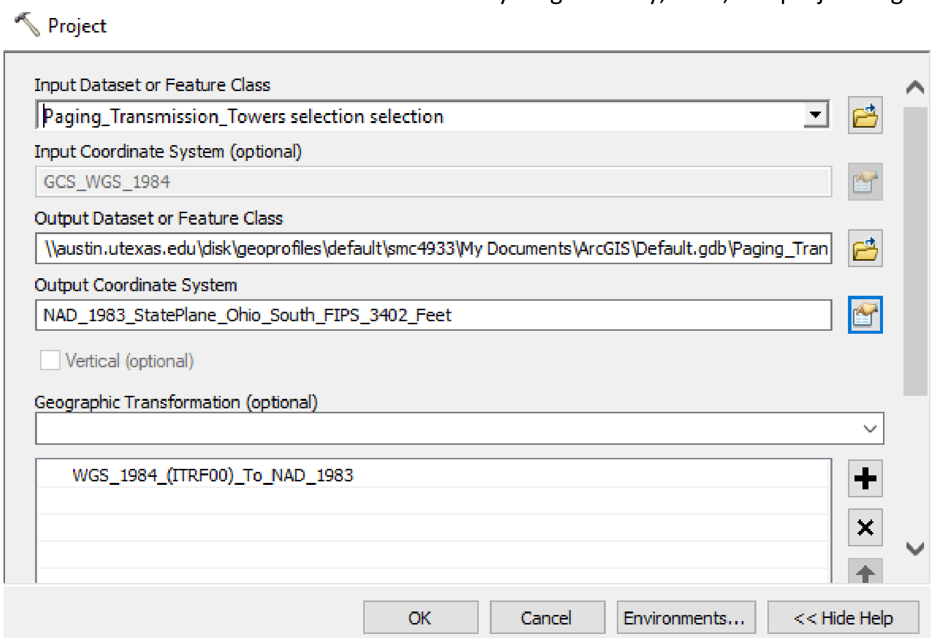

Figure 3. Project Tool

DEM and Aspect: The first step in creating a Westward or Eastward facing view, was to use the "Extract by Mask" tool in the Spatial Analyst Toolbox. This is the raster equivalent of clipping a layer to the Cuyahoga County (Fig. 4).

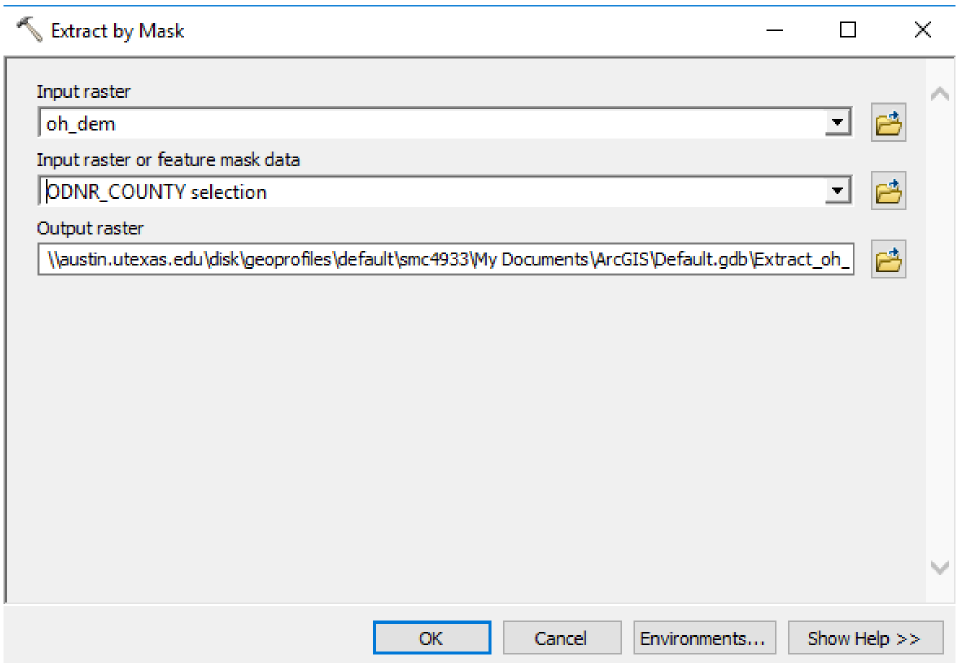

Figure 3. Extract by Mask of Cuyahoga

The masked area was then given the aspect- the direction of slope- of the county using the "Aspect" tool in the Spatial Analyst toolbox (Fig. 5).

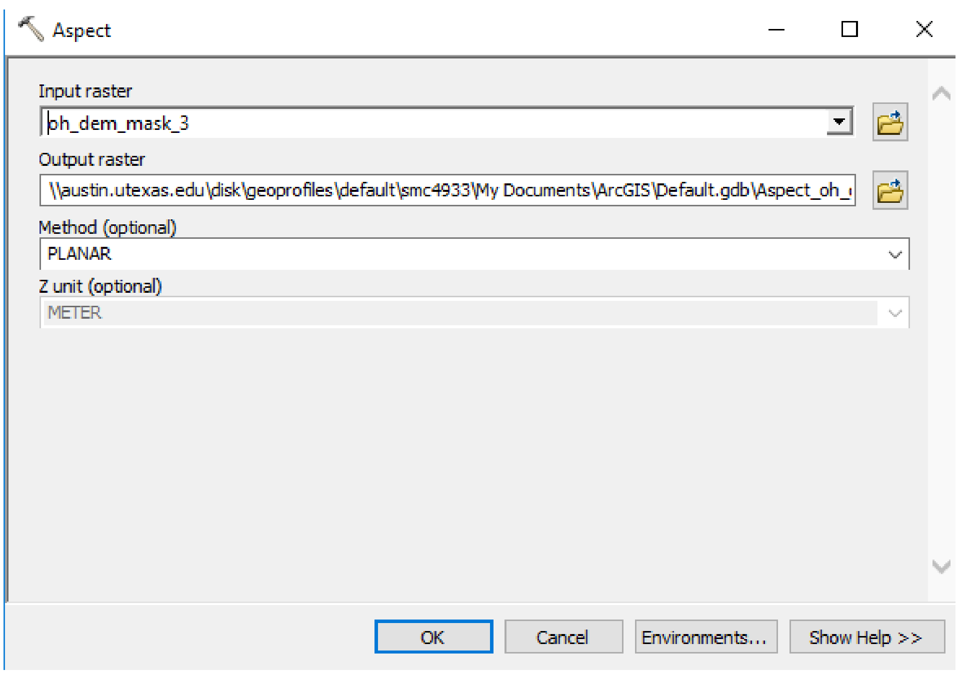

Figure 5. Aspect Tool

I then used the "Reclassify" tool in the Spatial Analyst Toolbox to clean up the direction. I set the new value 1 equal to every geographic value below 247.5, set value 2 equal to 247.5 – 292.5 (the west facing direction), and set value 3 equal to geographic value above 292.5 (Fig. 6).

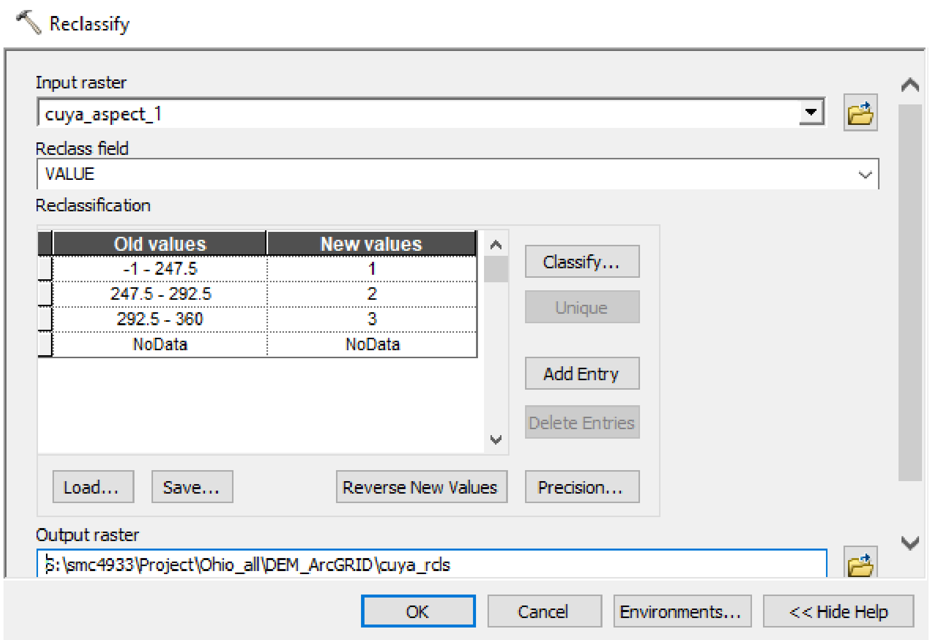

Figure 6. Reclassifying direction from Aspect

Lastly, I used the "Raster Calculator" tool in the Spatial Analyst Toolbox to create a new raster comprised of only the new value 2- the West facing direction (Fig. 7 and 8). The same process was done to create an east facing raster, using east facing values for Reclassifying (Fig. 9).

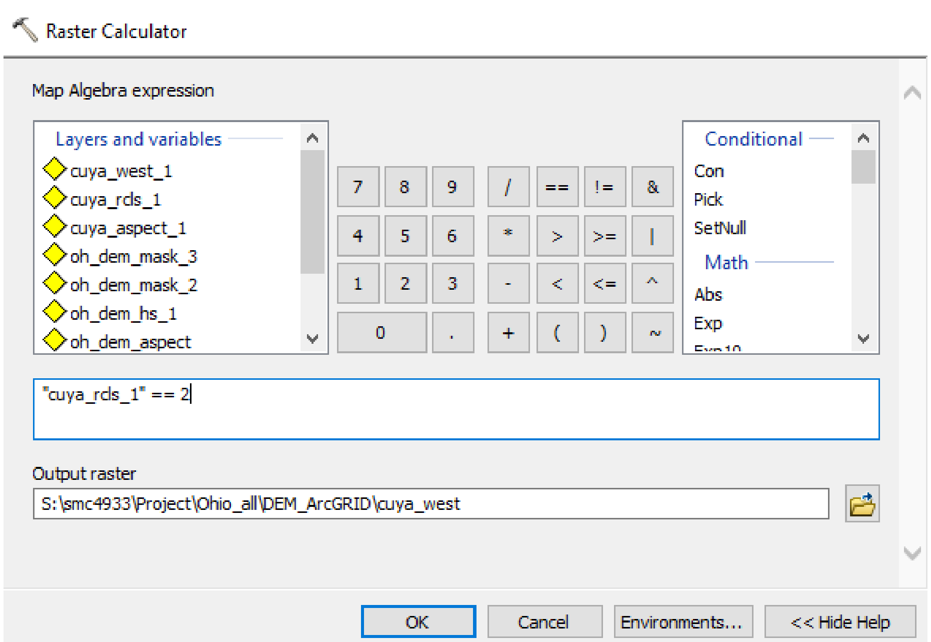

Figure 7. Raster Calculator – Directional facing raster

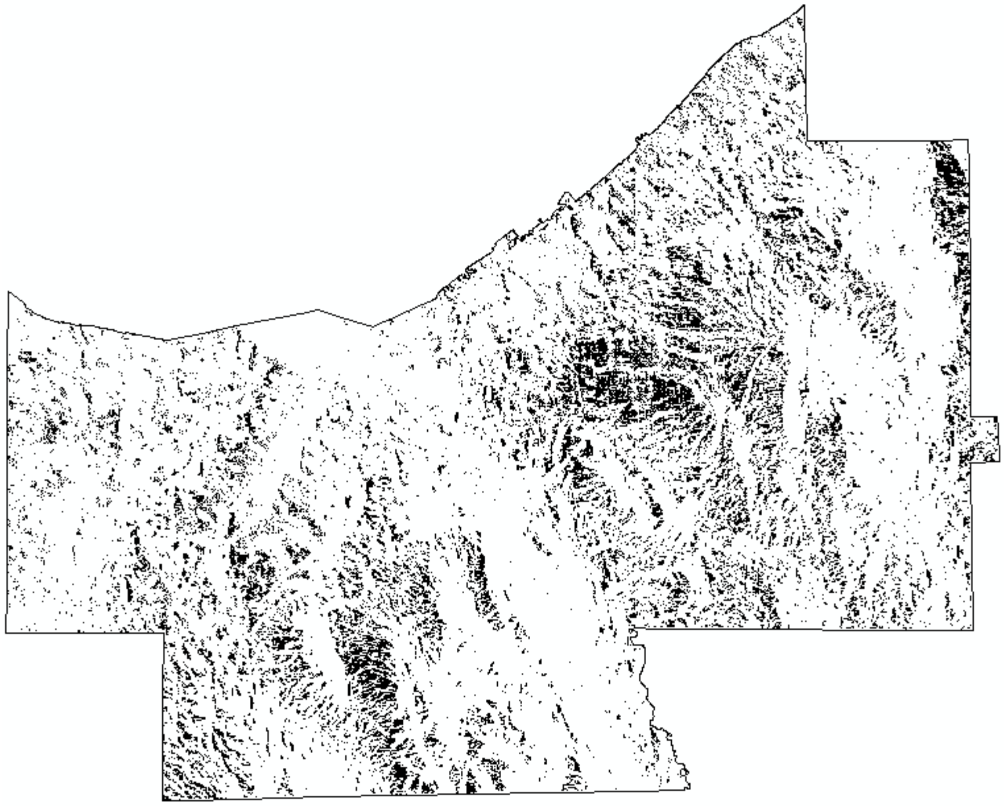

Figure 8. West facing Raster

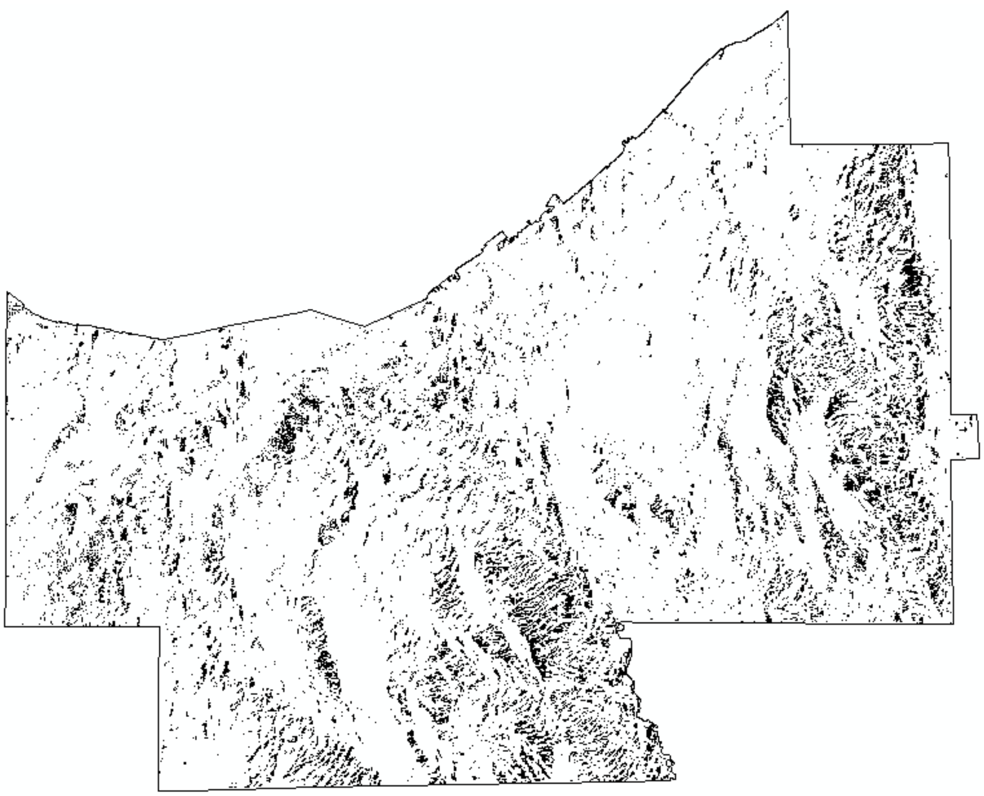

Figure 9. East facing Raster

Landcover: The culc94 shapefile contains polygons of different landcover in Cuyahoga County. Just like the tower layers, the spatial reference was projected to NAD 1983 State Plane Ohio South FIPS 2402 Feet (Fig. 10).

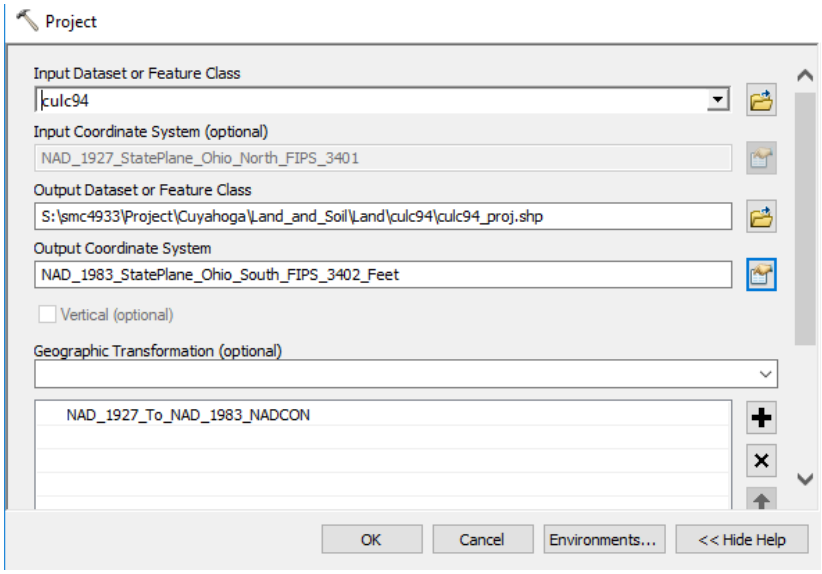

Figure 10. Project Tool

For this project, I imagined an open area where one could picnic or layout and enjoy the sunrise or sunset. Therefore, a grid containing Codes 2 and 3 were desirable (Fig. 11).

TABLE NAME: culc94.dbf **ITEM NAME:** GRID-CODE

CODE	DESCRPTION
1	URBAN (open impervious surfaces: roads, buildings, parking lots and similar hard surface areas which are not obstructed from areal view by tree cover.) See 7. BARREN
2	AGRICULTURE/OPEN URBAN AREAS (cropland and pasture; parks, golf courses, lawns and similar grassy areas not obstructed from view by tree cover)
3	SHRUB/SCRUB (young, sparse, woody vegetation; typically areas of scattered young tree saplings)
4	WOODED (deciduous and coniferous)
5	OPEN WATER
6	NON FORESTED WETLANDS (includes wetlands identified from 1994 Thematic Mapper data as well as from the Ohio Wetlands Inventory)
7	BARREN (strip mines, quarries, sand and gravel pits, beaches) Many of the URBAN features identified in this inventory are constructed from materials obtained from the BARREN features. Because of this, there will on occasion be URBAN areas identified as BARREN as well as BARREN areas identified as URBAN.

Figure 11. Metadata information for culc94, obtained from the Ohio Department of Natural Resources Website

To create polygons of just Codes 2 and 3, I used "Select by Attributes" creating a SQL Query (Fig. 12). Create layer from selected features was then used. This showed just where landcover Codes 2 and 3 were located in the county.

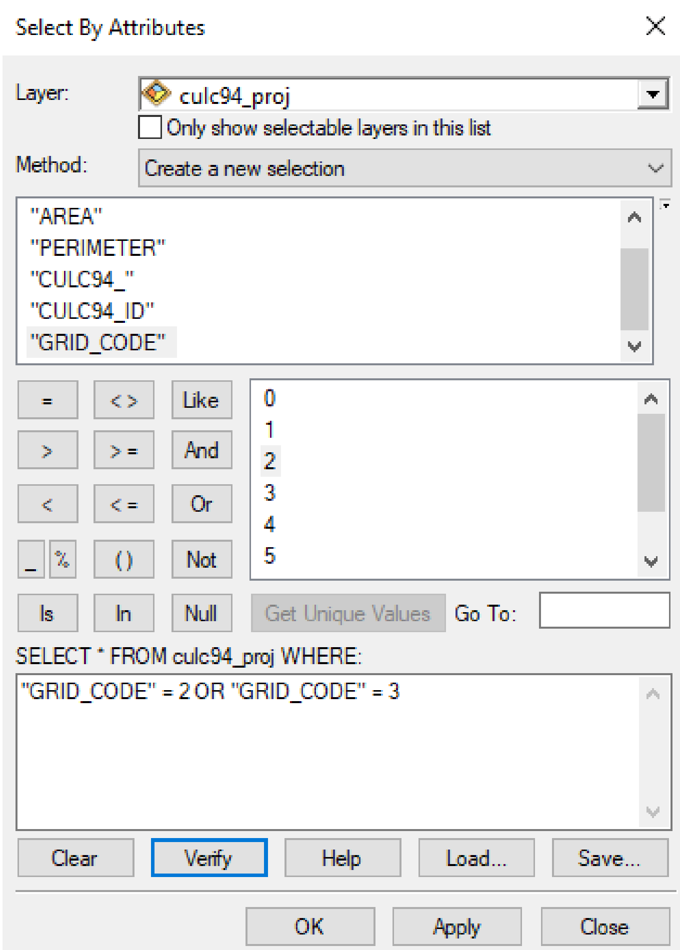

Figure 12. SQL Query for selecting polygons with landcover codes 2 or 3

These polygons then needed to be converted to raster, using the “Polygon to Raster” tool in the Conversion toolbox (Fig. 13). This is necessary so that I can combine in with the directional raster created from Aspect.

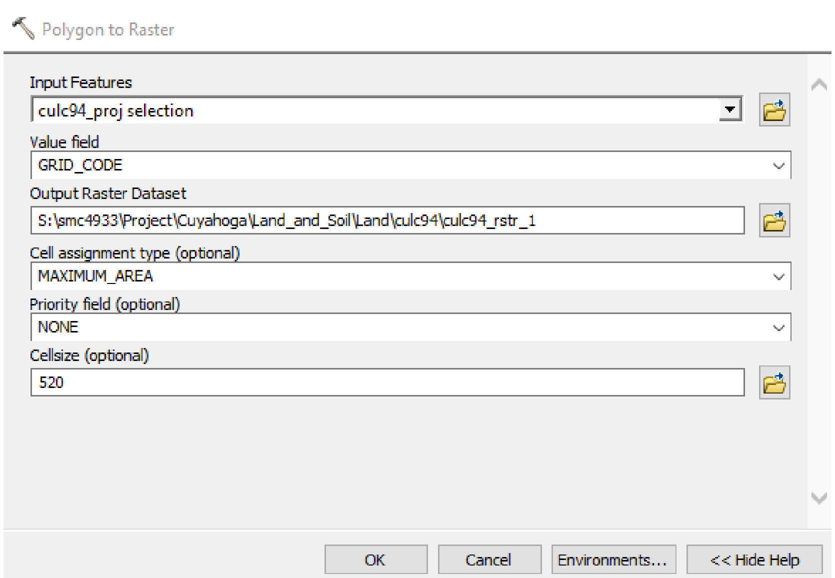

Figure 13. Changing landcover polygons to raster using the Polygon to Raster tool

I then used the “Reclassify” tool to create a binary raster of suitable landcover codes and NoData (Fig. 14 and 15).

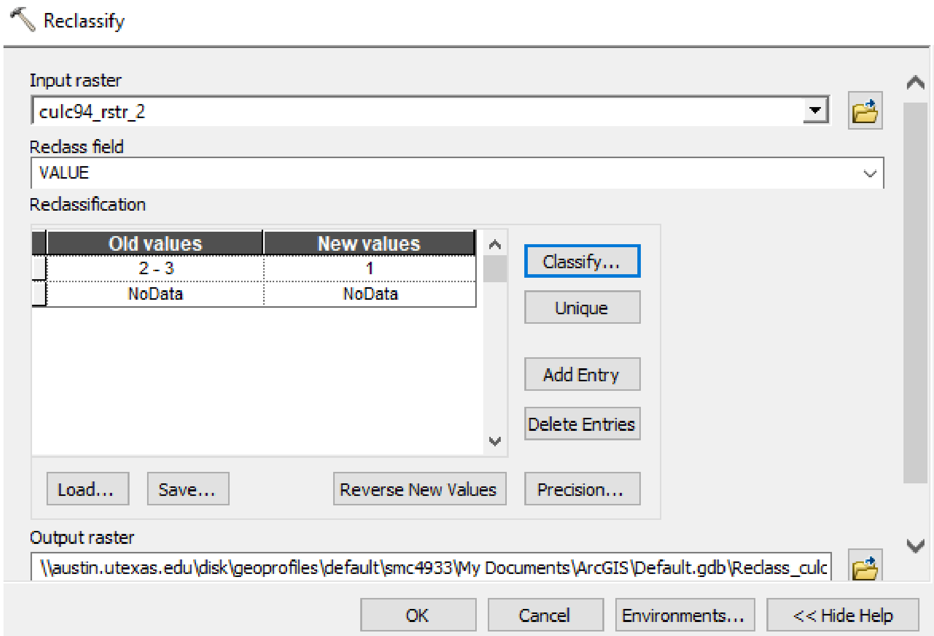

Figure 14. Reclasifying landcover codes into 1

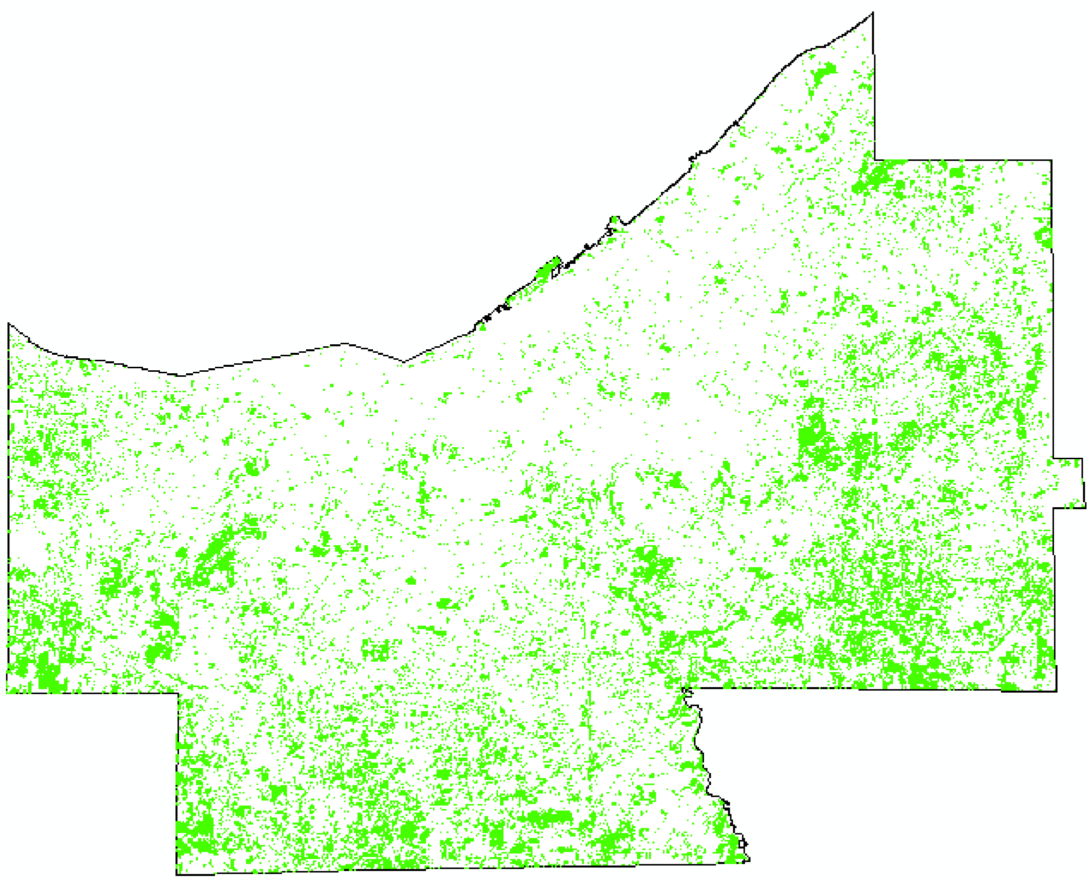

Figure 15. Landcover codes 2 and 3

Combining Suitable LancoverI then combined the suitable landcover raster and the westward facing raster in the Raster Calculator to create the main part of my suitability analysis. A conditional statement was used to create values of the suitable area and NoData (Fig. 16 and 17). The same steps were also done to create an east facing raster (Fig. 18). This area is all west facing and landcover code 2 or 3.

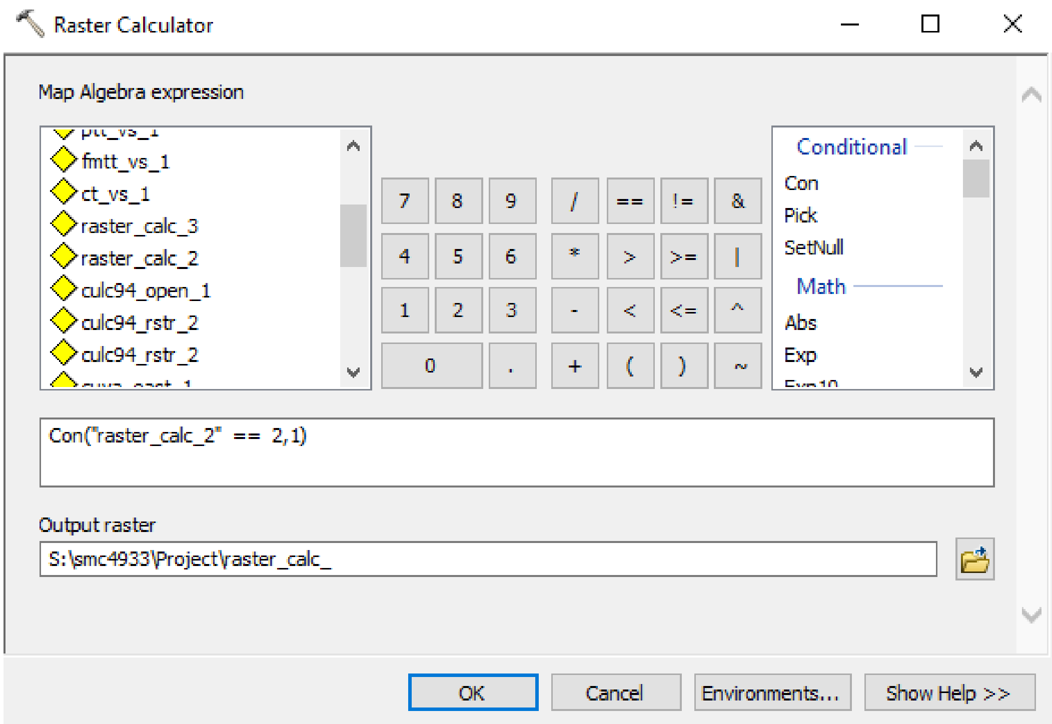

Figure 16. Raster Calculator

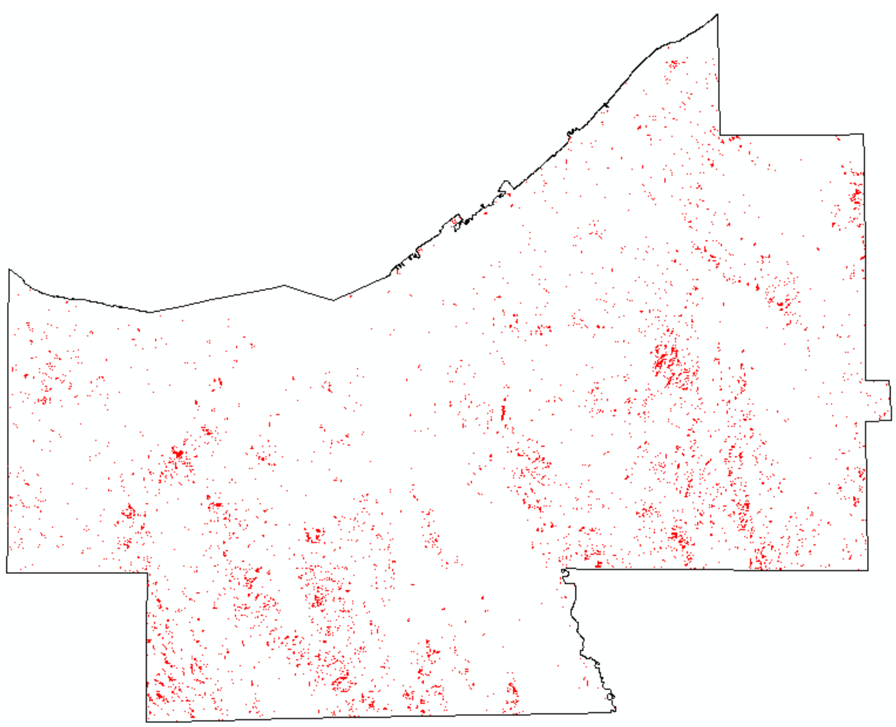

Figure 17. Raster of suitable landcover, west facing

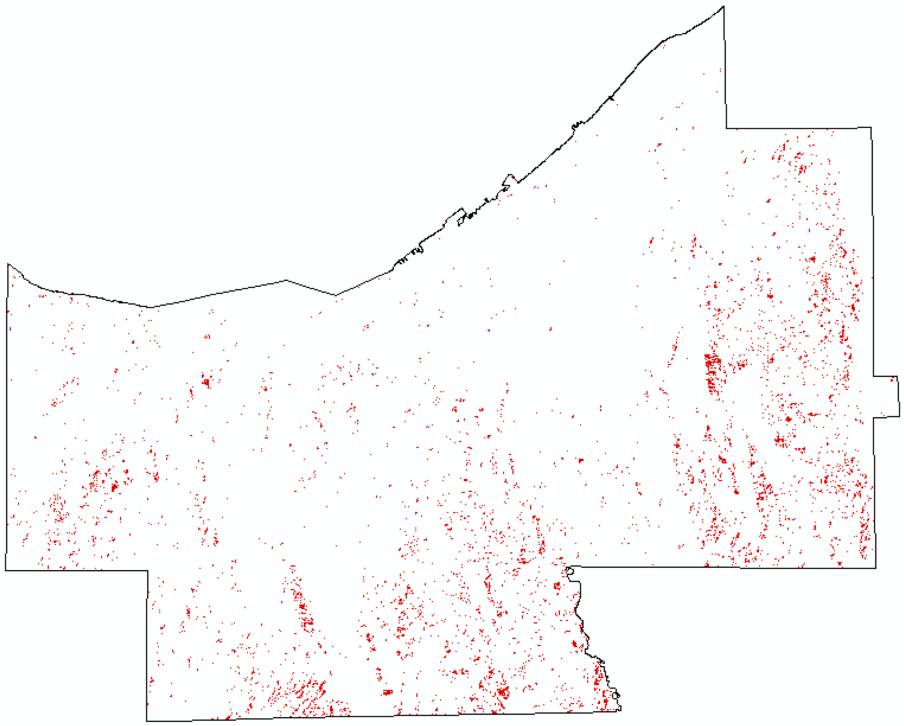

Figure 18. Raster of suitable landcover, east facing

Viewshed Analysis: A viewshed analysis was done to see if towers could be seen or avoided from the suitable area. The "Viewshed" tool in the Spatial Analyst Toolbox was used on each tower with the masked DEM as the input raster (Fig. 19).

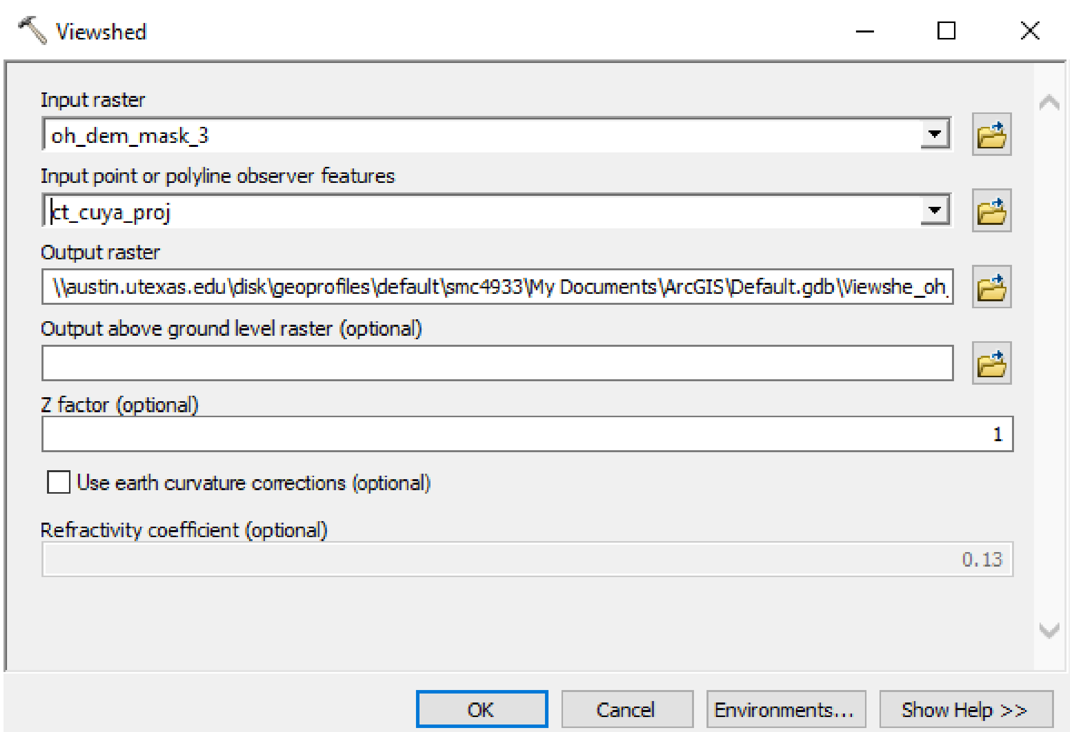

Figure 19. Viewshed analysis using Cell Towers as input point

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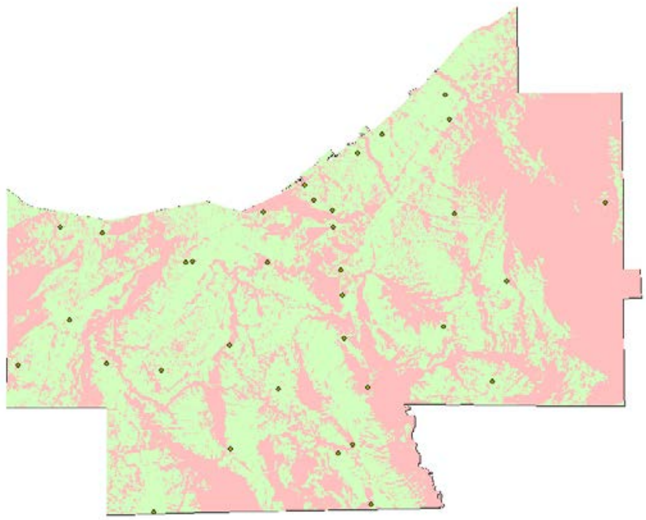
Note that this viewshed is from the base of the towers and not the top. This means that if the raster is green, the entirety of the tower can be seen, and some parts of the tower can be seen in red areas (Fig 20, A-C).



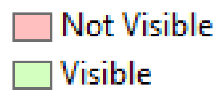
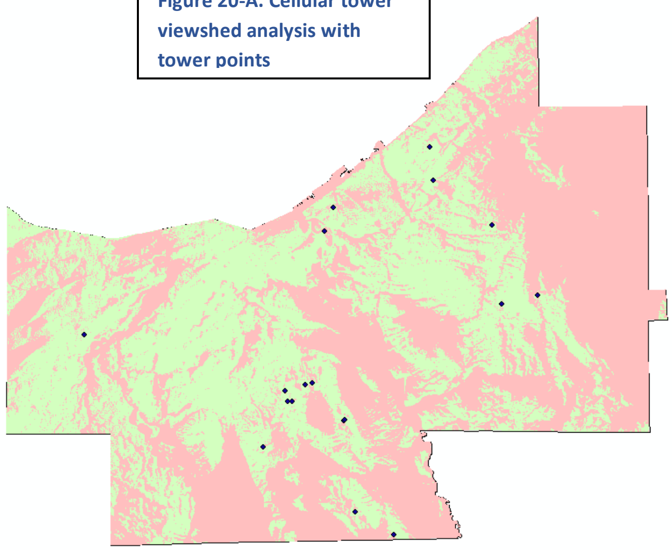


Figure 20-A. Cellular tower viewshed analysis with tower points



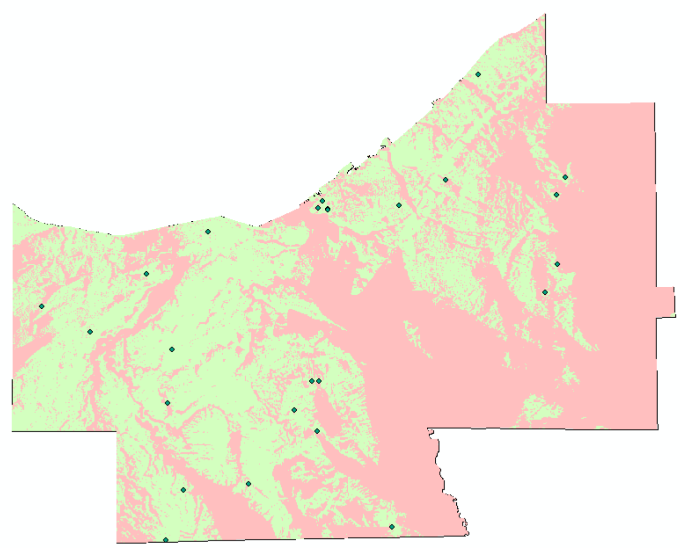


Figure 20-B. FM transmission tower viewshed analysis with tower points

Figure 20-C. Paging transmission tower viewshed analysis with tower points

To combat this, I combined the 3 rasters in Raster Calculator (Fig. 21). This produced a stretched raster of towers seen, from 0 to 53, at a cell. I then Reclassified the combine viewshed raster highlight the areas with no or few towers in sight (Fig 22). A Natural Breaks (Jenks) classification was used.

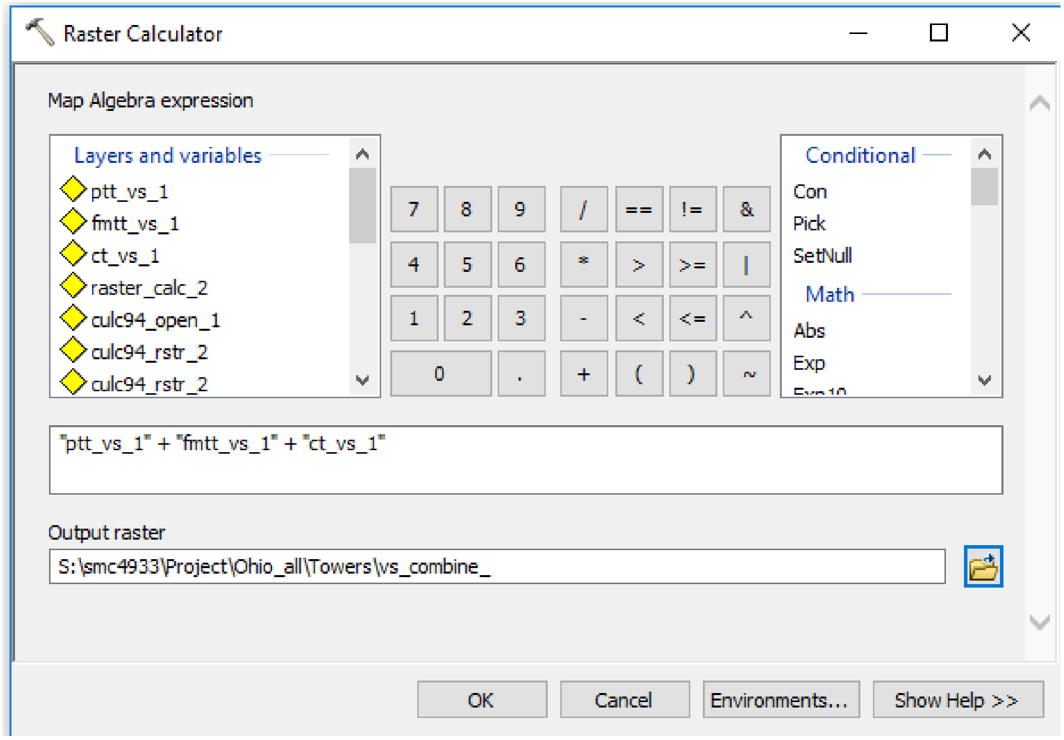


Figure 21. Using Raster Calculator to

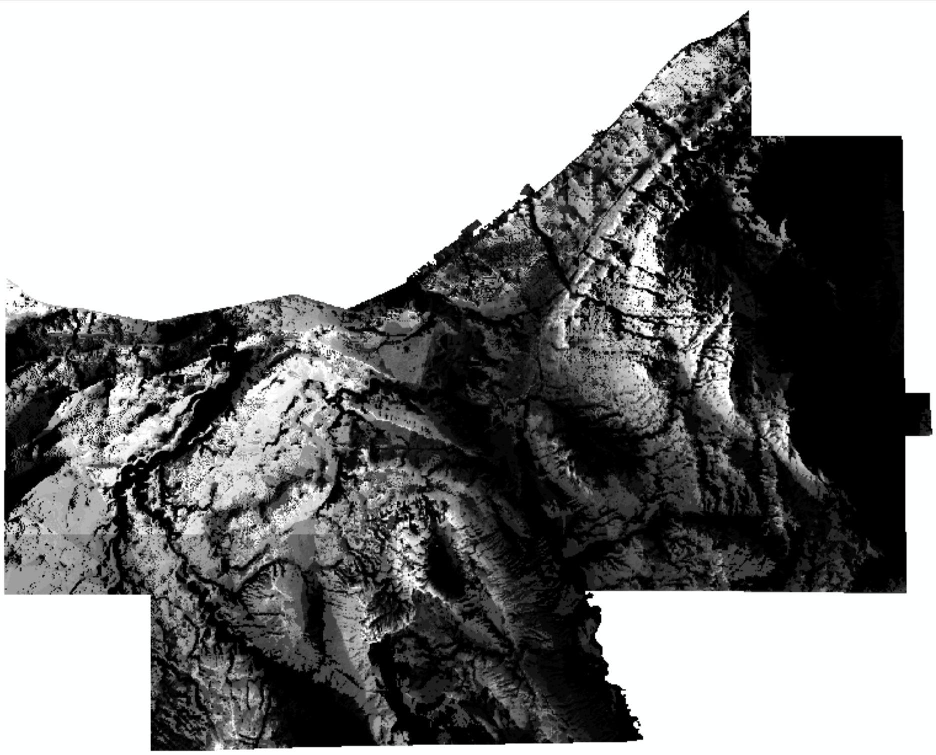


Figure 22. Viewshed analysis overlay of all 3 tower points.

Black = 0 = High visibility
White = 53 = Low Visibility

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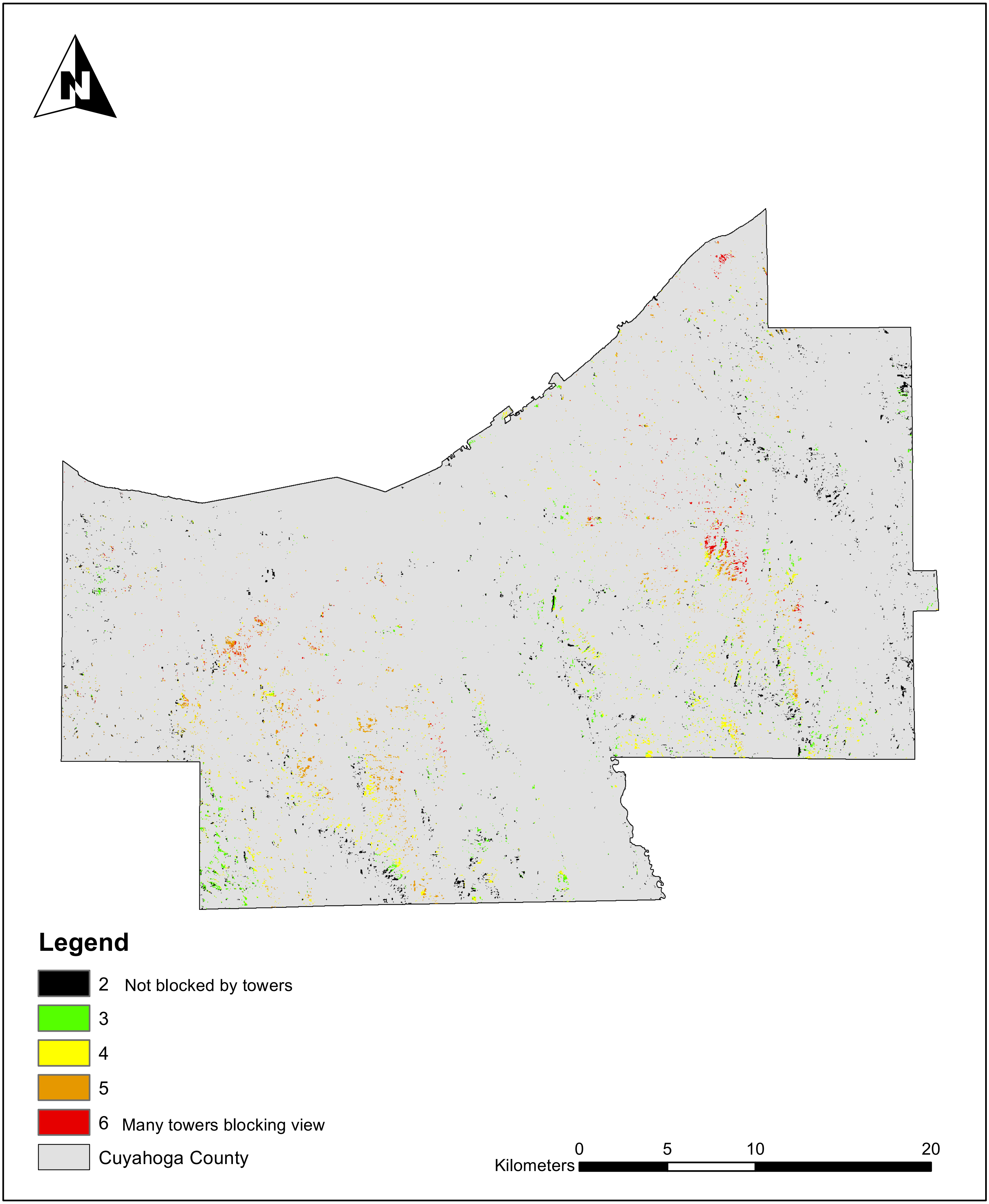
Suuitability Analysis: Finally, the westward facing suitability area and the viewshed rasters could be combined in the Raster Calculator to perform a suitability analysis(Fig.). The resulting raster is the best place to view a sunset in Cuyahoga County. The same analysis is done with the eastward facing suitable area to observe the best place to view a sunrise.

Suitability Analysis - Sunset



Suitability Analysis - Sunrise