SUITABILITY ANALYSIS: BEST VIEWS IN CUYAHOGA COUNTY
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 2. ArcCatalog Metadata of the DEM used

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

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).
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).

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 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).

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>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>URBAN (open impervious surfaces: roads, buildings, parking lots and similar hard surface areas which are not obstructed from aerial view by tree cover) See 7. BARREN</td>
</tr>
<tr>
<td>2</td>
<td>AGRICULTURE/OPEN URBAN AREAS (cropland and pasture; parks, golf courses, lawns and similar grassy areas not obstructed from view by tree cover)</td>
</tr>
<tr>
<td>3</td>
<td>SHRUB/SCRUB (young, sparse, woody vegetation; typically areas of scattered young tree saplings)</td>
</tr>
<tr>
<td>4</td>
<td>WOODED (deciduous and coniferous)</td>
</tr>
<tr>
<td>5</td>
<td>OPEN WATER</td>
</tr>
<tr>
<td>6</td>
<td>NON FORESTED WETLANDS (includes wetlands identified from 1994 Thematic Mapper data as well as from the Ohio Wetlands Inventory)</td>
</tr>
<tr>
<td>7</td>
<td>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.</td>
</tr>
</tbody>
</table>

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

Figure 14. Reclassifying landcover codes into 1

Figure 15. Landcover codes 2 and 3
Combining Suitable Landcover I 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.
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).
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).
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.
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

Legend

- **2** Not blocked by towers
- **3**
- **4**
- **5**
- **6** Many towers blocking view
- **Cuyahoga County**

0  5  10  20  Kilometers
Suitability Analysis - Sunrise

Legend
- 2: Not blocked by towers
- 3
- 4
- 5
- 6: Many towers blocking view
- Cuyahoga County

Kilometers

[Map showing suitability analysis with different color codes indicating the number of towers blocking view.]