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Advanced GIS

Homework Assignment

29 October 2013

Analysis Procedure/Summary:

There will be several steps to completing this project. But first, what is this project? This project is finding out who will be able to see a proposed (fictional) wind turbine on the ridgeline of Mt. Tom in Holyoke, Massachusetts. To complete this analysis, I will need several datalayers and geoprocessing tools. These tools and layers are all listed below but this, in summary, is how I would need to execute this analysis:

- Get a DEM (Digital Elevation Model) for Massachusetts
- Get a town boundary layer so that I can cut out the three towns; Easthampton, Southampton, and Holyoke, MA.
- Extract by mask the DEM to the three towns. (This will allow me to focus strictly on the three town's DEM's rather than the whole state)
- Use the Viewshed tool to show which areas will/will not be able to see the proposed wind turbine.
- Use the Land Use layer to determine which areas are forested and may be shielded from the view of the turbine.

I will be siting this turbine on the highest point of the mountain range. To do this, I used the DEM and the Raster Calculator tool to determine which cell is the highest in elevation, and digitized this as my point of interest layer.

After completing these steps, I will be able to analyze who can see the wind turbine on Mt. Tom and also what you can see from the wind turbine.

Data Layers:

Datalayer	Description and Use	Source
Digital Elevation Model (DEM)	The Digital Elevation Model represents surface elevation for Massachusetts. The layer was created from the digital terrain models that were produced as part of the 1:5,000 Black and White Digital Orthophoto imagery project.* For this project, this raster layer will be used for finding suitable elevation and also as the input raster grid for some geoprocessing tools.	MassGIS data layers - http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/imgelev5k.html
Land Use Layer (2005)	The Land Use (2005) datalayer is a Massachusetts statewide, seamless digital dataset of land cover / land use, created using semi-automated methods, and based on 0.5 meter resolution digital ortho imagery captured in April 2005.* For this project, this layer will be used to find the forested areas in each town.	http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/lus2005.html
Town boundary layer	The Community Boundary layer consists of all of the communities in Massachusetts on a 1:25,000 scale. Not only does this layer show the boundaries for each community, but it also shows the population for several different years, population change, name, and type of community (c-city, t-town, tc - Town with City form of government)* For this project, this layer will be used as a way to mask other features so that you only have to deal with specific towns instead of the whole state.	MassGIS data layers - http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/towns.html

Points of interest layer	This layer will consist of your points of interest that you want to know the viewshed for - how visible it is to other people and what can you see from that point. For this project, I will be digitizing my own point (highest point on Mt. Tom)	Your own data - can be digitized in ArcMap and saved or you can get it off of a website or from a friend.
Basemap	There are several different basemaps that you can choose from in ArcGIS Desktop. The most basic ones are topographic, streets, light grey canvas, imagery, imagery with labels, terrain with labels, oceans, national geographic, and open street view.There are many more to choose from on ESRI's website as well. For this project, I will be using a few different basemaps. For the first data frame, I will be using the population density to show how many people live in the area of the viewshed. For the second data frame, I decided not to use a basemap as there is already a lot going on and I feel that the basemap would only detract from the information being displayed. For the third data frame, I will be using an imagery basemap so that you can see what is currently on the land as compared to the land use layer.	Supplied in ArcGIS Desktop under "Basemap"

**Descriptions were taken from help.arcgis.com. Anything after the asterisk was my own description of the tool.*

Geoprocessing Tools:

Geoprocessing Tool	Description and Use	Online Help URL
Select by Attribute	I used this tool (not really a geoprocessing tool but a very handy tool to know) to select my three towns (Holyoke, Southampton, and Easthampton, MA). I also used this to find all of the forested areas with my land use layer.	http://resources.arcgis.com/en/help/main/10.1/index.html#//00s500000021000000
Raster Calculator	I used this tool to find the highest point on Mt. Tom.	
Extract by mask	Extracts the cells of a raster that correspond to the areas defined by a mask.* For this project, I will be using it to extract one town's boundary to eliminate all other clutter and information around my specific town.	http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//009z0000002n000000.htm
Clip	I used this tool to clip the land use layer to each town so that I could work with just that one town's land use.	http://resources.arcgis.com/en/help/main/10.1/index.html#//000800000004000000
Viewshed	Determines the raster surface locations visible to a set of observer features.* For this project, I will be using Viewshed to determine who would be able to see the wind turbine.	http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/Viewshed/009z000000v3000000/

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Documentation:

Needed data layers:

Town boundary layer

Land Use Layers (2005) - Hampden and Hampshire counties

Digital Elevation Model

- Used the Select by Attribute tool for the town boundary layer.
- Used the Select by Location tool to select land use inside the three towns.
- Used Extract by Mask tool to select the DEM for the three towns.
- Digitized highest point of Mt. Tom using the raster calculator and the DEM to find the highest point on Mt. Tom.

Question #1: Determine the percentage of Easthampton, Holyoke, and Southampton from where these wind turbines will be visible and create a map showing these areas.

- Added a field to the attribute table of the highest point OFFSETA. This tells the program that I want my viewshed to be calculated from a certain height.
- Viewshed tool to find viewshed for all three of the towns using an OFFSETA of 121m (400ft) - full height of the wind turbine.
- Extract by mask for each town to get the viewshed for each individual town
- Attribute table for each town; visible and non-visible cells - calculated square meters by multiplying 5*5*visible/non-visible cells (divide by 4,047 to find acres)
- Calculated the percentage of visible/non-visible cells by taking the calculation above and dividing it by the total number of cells/square meters in each town.
- Added a population density basemap to show which areas are more heavily populated and where more people would be affected by the view of the wind turbine.

Question #2: Expand your analysis from question 1 and account also for the degree of visibility; 100%, 75%, 50%, and 25%.

- Used the highest point of Mt. Tom as my point of interest. For each layer, I added an OFFSETA field - this told the program that I wanted my viewshed to be calculated from a certain height - 400 ft, 300 ft, etc. I copied and pasted a new digitized point with an OFFSETA appropriate for each percentage.
- Viewshed tool to find 100% visibility - with an OFFSETA field of 121m (default unit) or 400ft high, ran against all three towns.
- Viewshed tool to find 75% visibility - OFFSETA field of 90.75m or 300 ft high.
- Viewshed tool to find 50% visibility - OFFSETA field of 60.5 m or 200ft high.
- Viewshed tool to find 25% visibility - OFFSETA field of 30.25m or 100ft high.

These different percentages will show what areas will be able to see all of the turbine or just portions of it.

- After all 4 viewsheds were run, they were layered on each other with the 100% visibility on the bottom and descending upwards so that you are able to see the differences in each of the viewsheds.

  Since this was a very busy data frame, with the 4 different layers, I decided not to add a basemap to my poster. I felt as though this would just detract from the information that I was trying to display.

Question #3: Expand your analysis additionally by accounting for the screening effect of trees.

- Land use layer: Clip tool to select features only inside each of my towns.
- Select by attributes to find all of the forested areas (code #3)
- Export data to show only the forested areas
- Percentages: Attribute table for all land usage - statistics, sum = all of the land usage
  - Attribute table for forested areas - statistics, sum = all of the forested land
  - Divided the forested area by the total land usage to find percentage.

- Layered over an imagery basemap with a transparency of 75% so that you can see the land underneath to confirm that the land use is at least somewhat correct.

I decided to visualize the different percentages by using pie charts. I created a pie chart for each percentage (100, 75, 50, and 25) and also for the town percentages of forested areas. On my poster, I also added a raw data table so that people can see the numbers for themselves.

Flaws of this analysis:

1 - Old data. The land use layer that I used for this project is about 8 years old. Many changes could have happened from 2005-present day.

2 - Vegetation shielding. While the vegetation (trees) may shield some residents from the view of the turbine, this shielding effect may not last all year round. If the resident is surrounded by deciduous trees, they may be able to see the turbine in the fall and winter months when the leaves have fallen from the trees.

3 - Structural effects. This analysis does not take into account for the shielding effects of surrounding structures like buildings. This is an important factor to keep in mind but not one that is focused on for this analysis.

4 - Raster cell accuracy. Since we have to convert the raster cells into square meters and then eventually acres, we may lose some accuracy during these calculations.

Ways to minimize flaws:

1. Get the newest data possible. While I used the newest data possible for the land use layer, you must always be aware of what year your data was created. This will allow you to keep in mind that the data may have changed and to keep a lookout for the newest data possible.

2 - Ground-Proof (Truth). While you may not have time to go out and look at every single parcel and decide if they will be able to see the turbine in the fall or winter, you can get the public involved. One really cool way that I've been told about is by "crowd-sourcing" - Fly a balloon at 400 feet above Mount Tom (with a rope attached to the ground) for 1 to 2 weeks. Then have a website and smartphone app where folks can report their location and whether or not they can see the balloon. This would be a really cool way to get the public involved.

3 - Account for structural effects. This can be done with ArcScene if you have a good data set that shows all of the buildings in the town. With this, you can see if the current structures in each town would block the view of the turbine, at least in part, for some residents.

4 - Minimize conversions. By minimizing the amount of calculations you do and how much you convert the data, you will minimize the amount of accuracy lost in said calculations.