GIS-Based Lesson: Raster and Vector Analysis: Fire Tower Analysis

Name_____

Skills Involved:

1) Analyzing raster data.
2) Downloading and formatting public domain vector data (DLG) and raster data (DEM, NLCD).
3) File and data management within a GIS environment.
4) Merging and clipping themes.
5) Symbolizing themes based on attribute values.
6) Analyzing raster and vector data together.

Raster Analysis

Wildfires in the United States are an increasing problem. Wildland fires consumed over 7 million acres in 2002 alone. In this lesson, you will locate the best site for locating lookout towers for firefighters to spot wildfires in the Loess Hills in the vicinity of Blair, Nebraska. The study area will be the 7.5-minute x 7.5-minute cell that the town of Blair falls in. In this lesson, you will download Digital Line Graph (DLG), Digital Elevation Model (DEM), and National Land Cover Dataset (NLCD) public domain data from the Internet, format them for use in ArcGIS, and create derivative data from the DEM (contour lines, a slope map, and an aspect map). Next, you will have the opportunity to further analyze these data sets to locate your fire towers.

The criteria for the fire towers are that they must be:

1. Within 100 meters of a roadway, for easy access.

2. Within 200 meters of a river, for access to water.

3. At least 380 meters in elevation, for the best visibility of the surrounding terrain.

4. On a slope of less than 5 degrees, to minimize construction costs and maximize ground stability.

5. On pasture/hay fields, since these are the grassy areas most susceptible to wildfires in this area.

In the first section of the lab, you will download a USGS DLG from the Internet, format it for use in ArcGIS, and analyze roads and hydrography for criteria 1 and 2, above.

First, create a folder named "blair" (or another name that you will be able to correctly manage, without spaces in the folder name).

Go to http://www.gisdatadepot.com. This is a site run by www.geocomm.com, and

offers *Spatial News*, information about the geospatial community, and also serves government and other data, some for free, and some for sale.   Much of the same data is available for free or for sale, with the difference being that those who pay receive a faster download pipe.

At the GIS Data Depot, select "Download GIS Data."

Select Nebraska.

Select "County-wide layers" and navigate to the county that Blair is in.

To find the county name that Blair is in, do the following: Open a new web browser window and find out which county Blair is in by accessing the USGS Geographic Names Information System (GNIS). The GNIS is a database of every name that occurs on USGS topographic maps, on: http://geonames.usgs.gov.

Query US States and Territories and find Blair, Nebraska as a populated place.

1) What county is Blair in?

Go back to your GIS Data Depot list. Navigate to the correct county, and then select 1:24,000-scale DLG.

* You will need to create a Geocomm account to download the data.

After creating your account, download the Roads and the Hydro file for the Blair 7.5-minute x 7.5-minute cell.

Note: The DLG data from GIS Data Depot is also available on the following site:

http://edc.usgs.gov/geodata

by selecting 1:24,000-scale DLGs.

Select "Alphabetical List" and navigate to the "B" folder. Select Blair from the list and download the Roads and Hydro files.

2) The vector format you are downloading is SDTS (Spatial Data Transfer Standard) format. What is the name of the other format for the DLG data that is available?

SDTS is very particular about the location of the data in relation to the master data dictionary, which contains information that the SDTS files need to access.

Make sure you download the Master Data Dictionary into a folder named masterdd. This folder must reside 1 level up from the folder(s) where your data resides.

Before you unzip these files, make sure the setting in WinZIP → Options → Configuration for TAR file smart CR/LF conversion is UNCHECKED. The location of this setting may be slightly different depending on your version of WinZIP. Sometimes, the CR/LF setting causes problems with spatial data.

Indicate "yes" if WinZIP asks you if you wish to decompress to a temporary folder and open.

3) What is the 4 digit code at the beginning of all roads file names that indicates that they are part of the transportation theme?

4) What is the 4 digit code at the beginning of all hydro file names that indicates that they are part of the hydrography theme?

Access ArcMap and start a new map document.
Access ArcToolbox.

In ArcToolbox, access:
        Coverage
                Conversion
                        To Coverage
                                Import from SDTS

Convert the transportation files and the hydrography files using this tool.

Leave the default names of the resulting coverages alone:

HY01
TR01

5) Examine your data (using Windows Explorer) for the hydro and transportation data. How is each coverage stored—as a file or a folder?

Therefore, to provide an easier-to-use file format in which to work, use Data→ Export

Data to export your coverages to shapefiles, named hydro and roads, or some other suitable name.

In ArcMap, use Add Data, but after navigating to the correct folder, **expand** the folder for HY01 and add arcs only. Do the same with the arcs for TR01.

6) Why does the 7.5-minute cell for Blair appear to be "tilted" with the northeast corner appearing farther north than the northwest corner?

Examine the coordinate system; especially taking into account the UTM zone. Because the land cover and elevation that you will bring in is in NAD 83, change the data frame properties to UTM NAD 83, with the same UTM zone as the zone it was in before.

You will need to buffer the roads and hydro to select the areas that are within 100 meters of roads and 200 meters of rivers to consider for your fire tower locations. However, first consider the following before you buffer.

7) Are all of the features in the roads layer truly roads? Are all of the features in the hydro layer truly hydro features? Why or why not?

Find an attribute in the table for roads and hydro that would allow you to use "select by attribute" to narrow down your data set for only features that are true roads and hydro.

8) Indicate your expression for Select By Attribute, for roads and hydro, below:

Use ArcToolbox → Analysis Tools → Proximity to buffer the roads according to the criteria for your fire towers.

Buffer the rivers according to the criteria for your fire towers.

Zoom in on a few of your buffers and use the measure tool to answer the following question.

9) Are the buffers of x meters x meters on each side of the feature, or x meters total? In other words, are your 100 meter buffers 100 meters on each side of roads, or 100 meters across?

Use the Intersect tool to intersect your roads and hydro buffers.

10) How much of the Blair terrain would you **estimate** is currently under consideration for your fire towers?

Now that you have selected areas near roads and streams using your Digital Line Graph data, you are ready to address criteria 3 and 4 for your fire towers. To do so, you will need to download and format your Digital Elevation Model (DEM) data from the USGS Seamless Data Server. These DEMs have been vertically integrated with

hydrography data, standardized on elevation units, and edgejoined with adjacent DEMs to form the National Elevation Dataset (NED). You will also need to download and use the 1992 National Land Cover to determine where grassy areas exist.

The data you will access, unlike the DLG data, is not stored by county or in 7.5-minute blocks. The user defines the block that he or she needs. To easily download the correct data block, you need to find the latitude and longitude for Blair. Do this by opening a new web browser window, and access the USGS Geographic Names Information System (GNIS). The GNIS is a database of every name that occurs on USGS topographic maps, on: http://geonames.usgs.gov.

Query US States and Territories and find Blair, Nebraska as a populated place.

11) What is Blair's latitude and longitude?

Second, you need to find the 7.5-minute latitude-longitude block where Blair falls into. You can obtain a paper USGS topographic index to find out the correct map name that the Blair area falls into. However, it is easier to check the scanned topographic indexes online, as follows:

Access MapLink on http://www.maplink.com:

Go to **USGS Topographic**.

Go to **Index Image**.

Go to the state where you are siting the fire tower.

12) What is the 1:250,000 scale map name that includes Blair?

13) What is the 1:100,000-scale map name that includes Blair?

Examine the map names that make up the 1:100,000-scale block and find the Blair 7.5-minute block.

14) Write down the southeast and the northwest (minimum and maximum) latitude and longitude coordinates **in decimal degrees** that bound the 7.5-minute area that covers Blair.

	Minimum	Maximum
Latitude		
Longitude		

15) Now, write down the southeast and the northwest (minimum and maximum) latitude and longitude coordinates **in degrees, minutes, and seconds** that bound the 7.5-minute area that covers Blair.

	Minimum	Maximum
Latitude		
Longitude		

Access the following site: http://seamless.usgs.gov for your elevation and land cover data.

Go to the link: View and Download United States Data

On the left, under Downloads, select "Define Area by Coordinates." You may have to allow pop-ups in your web browser on this site. Enter the minimum and maximum extent for the 7.5-minute block that you need for your study, entering the coordinates that you wrote down earlier.

You will see a screen indicating "Data Extraction Request Pieces."

Unselect the 1 arc second NED data. This 90 meter horizontal data is not of sufficient resolution for your study. You need the 10-meter horizontal NED data (1/3 arc second) to accurately site your fire towers.

Select the 1992 National Land Cover Data (resolution 30 meters)
and the
1/3 arc second NED data (resolution 10 meters).

Your screen should look similar to the following:

16) Why is the NED data block larger in megabytes than the NLCD block?

Create a folder named "nlcd" or "landcover" under your Blair folder and download the landcover data into this folder.

Create a folder named "ned" or "elevation" under your Blair folder and download the elevation (NED) data into this folder.

17) Is the NED and NLCD raster or vector data?

Therefore, Use Extensions to turn on the Spatial Analyst Extension.

18)   What are the low and the high elevation for this area?   (and you thought Cornhuskerland was flat!).

19) Examine the metadata for the elevation data. What are the units for the elevation data – feet or meters?

Use View→ Toolbars to turn on the Spatial Analyst toolbar.

You need to select certain elevations. However, examine the Selection→ Select by Attributes pull-down menu.

20) What layers can you select by attribute in your folder?

21) Why can you not select elevations?

Therefore, you will need a raster method to select the raster pixels that meet the criteria, which is equivalent to the select by attribute method for vector data.

On the Spatial Analyst toolbar, Use Spatial Analyst→ Raster Calculator to select areas that meet the elevation criteria for your fire towers.

22) What expression did you use?

23) What value do pixels have if they evaluate to be "true"?

Rename your "calculation" layer to something more suitable.

24) Approximately what percentage of your study area is suitable in terms of elevation for your fire towers?

Examine your attribute table for your new layer.

25) How many cells are suitable in terms of elevation?

26) Recalling the resolution of your elevation data, how much **land area** is suitable?

You now have criteria 1, 2, and 3 met for your fire towers.

27) Do you have a slope layer yet?

Create a slope layer using Spatial Analyst → Surface Analysis. Make sure your slope layer is in degrees, not percent.

Examine the resulting slopes.

28) What is the problem with the slopes values across the map?

The problem is because the data from the seamless USGS data server is not in any projection, but is latitude-longitude, mapped in the Data Frame to "look like" UTM. The horizontal units (degrees) do not match the vertical units (Meters), and so the slopes are incorrect. Therefore, you need to project the DEM data itself, not just the data frame.

In ArcToolbox, use Projections and Transformations → Raster → Project raster to project your raster data. Use your original DEM as your input raster, and give a name and location for your output raster. For projection, Select a Predefined Coordinate System. Choose UTM, Zone 14N, NAD 83.

Use Surface Analysis → Compute Hillshade to create a hillshade for your study area.

29) What landform feature is the flat area is in the northeast corner of the study area?

Remove your erroneous slope map layer.

Create a new slope map on your projected DEM data.

30) What is the maximum slope in the data set?

Use the Raster Calculator to select cells that are less than 5 degrees slope.

31) Approximately how much of the land area in your study area is suitable in terms of slopes for your fire towers?

Create a raster layer that meets **both** the slope **and** the elevation criteria, using Raster Calculator.

32) What expression did you use to accomplish this?

Save your map document often!

You have addressed the first 4 criteria for your fire tower analysis. Next, you will address the last criterion—locating the fire tower on grassy areas.

Examine the metadata for the National Land Cover Data (NLCD).

33) What do the numbers in the NLCD legend in ArcMap mean?

Examine the NLCD attribute table for Blair.

34) What are the 2 most common land use types in this area?

35) What is the code for pasture/hay?

Use the raster calculator to create a layer that encompasses criteria 3, 4, and 5; that is, the elevation, slope, and land use are all acceptable.

36) What expression did you use?

Make this layer permanent and give it a suitable (brief, since it is a grid) name.

This is a raster grid for criteria 3, 4, and 5, but criteria 1 and 2 are vector layers.

37) Can you intersect these two layers? Why or why not?

To consider ALL criteria at once, you must either convert your raster layer to vector and complete the analysis, or convert the vectors to raster. Each has its advantages.

Here, let's convert the raster layer to vector.
Use ArcToolbox → Conversion Tools → From Raster → Raster To Polygon. Convert your raster layer representing suitable elevations, slopes, and land use to a polygon shape file.

Examine the attribute table for your resulting polygon file.

38) What is the name of the field that indicates whether a polygon is suitable or not?

Open the attribute table and perform a summarize on this field.

Open the new summary table.

39) How many polygons meet the criteria in terms of elevation-slope-land use?

Save your map document.

Now you are ready for the final analysis!

First, select the polygons that meet the criteria in the polygon layer above (the layer that includes considerations of elevation, slope, and land use.

40) How many polygons have you selected?

_____ of _____

41) What is the spatial pattern of these areas in the study area of Blair?

Use Data → Export Data to export these suitable polygons to their own shapefile, called elevok_slopeok_landok or some other suitable name.

Next, Use ArcToolbox → Analysis → Overlay → Intersect to intersect:

Your suitable elevation-slope-land use areas (the elevok_slopeok_landok) layer above

WITH

Your suitable close-to-roads and close-to-hydro areas layer

Name your output layer "finalsites".

42) In which parts of the study area are you now considering the placement of your fire towers?

43) Where would you say is the largest concentration of suitable polygons in relation to the town of Blair?

Let's say these areas are the ones you will most strongly consider for your tower location.

44) How far is this concentration of suitable areas from the town of Blair?

45) Create a layout and print your final map that includes:

--Your final sites on top of a Hillshade
--an appropriate title, author, north arrow, and legend.
--Include any other layers you think are appropriate, such as roads or hydro.

Paste this layout into this lab document.

46) Speculate as to the differences in your final sites if you had made the final analysis a raster analysis instead of a vector one.

47) What steps would you have had to perform in ArcGIS to make the final analysis a raster analysis instead of a vector one?

Excellent! You have considered several factors for the location of your fire observation towers and used public domain data in your decision.

48) What other criteria and data might you want to consider if you had the time and funds for locating fire towers in this region or in any other region?

49) Summarize what you learned about public domain data in this lesson.

50) Summarize what you learned about ArcGIS in this lesson.

Save your map document and close ArcMap.

*** End of Fire Tower Analysis Lab ***