

LAB 7: ASSESSING FOREST DAMAGE & ANSWERING THE RESEARCH QUESTION

For Lab 7, I want to help you learn how to: a) analyze and visualize your forest data; b) wrap up the project by checking off all of your objectives; and c) build an answer to your research question.

Advice: *Read everything before doing anything* so you can visualize your workflow, plan your time, and anticipate what comes next. I also recommend printing this handout and taking notes on it as you work. You will appreciate these notes after you take breaks. Also, when saving outputs, give them useful names. Feel free to continue using the geodatabase that you created and used during Labs 5 and 6.

TASK 0: YOU HAVE ALL THE DATA YOU NEED. NO MORE DOWNLOADING.

Open ArcMap, create a new and empty map document, and set your default geodatabase.

Use **File > Map Document Properties** to **Store relative pathnames to your data sources**. You'll recall from GIS1 that checking this box helps you to avoid getting those red checkmarks (broken links) as you move your data from one computer to another.

Use **File > Page and Print Setup** to divorce your map size from the default paper size in your printer. We want your map canvas to fit between the margins of your report without any resizing or resampling, so reset your map to be 6.5 inches wide by 6.5 inches high. When this size layout is exported from ArcMap as an image, it will insert perfectly between the margins of your lab report – no resizing needed.

Next, **Save** your empty map document as **BurnSeverity.mxd**.

TASK 1: TERRAIN ANALYSIS

Make sure the **Spatial Analyst** extension is checked on. Derive **Slope** and **Aspect** surfaces without adding your **DEM** as a layer. I want you to see it is possible to run analysis tools by pointing to data in your database; you don't need to make layers out of everything before running a tool.

Next, calculate a **Hillshade** surface for November 23, 2016 @ 4 PM without adding your **DEM** as a layer. The solar position at that November moment was 14° alt., 235° az. Feel free to model shadows across this mountainous terrain.

This time, **Add** your **Vegetation Burn Severity** surface as a layer. The burn severity surface holds five integer values that express the ordinal severity scale described by J.E. Keeley (2009)(Table 1).

Next, you're going to **Customize** ArcMap by adding the **Effects toolbar**. With the Effects toolbar, (via its pull-down menu) make your **Vegetation Burn Severity** surface the active layer. Next, select the **Swipe** tool (hover over the buttons in the Effects toolbar until you find the Swipe tool). Next, use your mouse to swipe left-and-right (or up-and-down) across your map view window. As you change scale (zoom in/out), pan, and swipe, take time to interpret the terrain wherever you find the highest and the lowest severity scores.

Question 1: What was the apparent relationship between vegetation burn severity and hill slope gradient and aspect during the Chimney Tops 2 Fire? (Do not describe your map view – i.e., left, right, top, or bottom; describe what your map view represents - north, south, east, and west.) (2 pts)

Table 1. Keeley’s (2009) ordinal severity scale with descriptions and raster coded values.

Burn severity	Description	Raster value
Unburned	The green plant parts (leaves or needles) are still green and unaltered; they exhibit no direct effect from heat.	0
Scorched	Unburned, but plants exhibit leaf loss from radiated heat.	1
Light	Canopy trees still have leaves or green needles, but scorched stems. Surface litter, mosses, and herbs were charred or consumed. Soil organic layer intact; soil charring limited to < 1 cm.	2
Moderate	Trees with some canopy cover killed, but needles were not consumed. All understory plants charred or consumed. Fine dead twigs on soil surface were consumed and logs are charred. Pre-fire soil organic layer was largely consumed.	3
Deep	Canopy trees killed and needles consumed. Understory, surface litter of all sizes, and soil organic layer were consumed. White ash deposition to several cm depth.	4

Source: Keeley, J.E. 2009. Fire intensity, fire severity and burn severity: a brief review and suggested usage. *International Journal of Wildland Fire* Vol.18, p.116–126.

Save your map document and **close ArcMap**.

TASK 2: TERRAIN ANALYSIS IN 3-D

Open **ArcScene**, create a new and empty scene document, and set your default geodatabase.

Use **File > Scene Document Properties** to **✓Store relative pathnames to data sources**.

Next, **Save** your empty scene document as **BurnSeverity.sxd**.

Add the **Percent Tree Cover** surface as your first layer. Change the color **symbol** for the “0” percent value from black to light grey, but keep all the other colors the same. After the change, you should notice that there are more open areas on the landscape than you might have thought at first.

Next, change the **base height** property of your **Percent Tree Cover** layer by floating it over your **DEM** (you don’t need to add the **DEM** as a layer; just point to it). Don’t forget to check on the **shade effects!**

If you’re having trouble visualizing the relief, then edit your **ArcScene > View > Scene Properties** and increase the **Vertical Exaggeration** from none to “3”. You may recall that we had to exaggerate the z axis earlier this semester while working with the Crater Lake data. While you’re here, change the **Illumination** properties of your scene to match the solar position that you used in Task 1.

Next, **add** the **Vegetation Burn Severity** surface as a new layer. Change the color **symbol** for unburned cells to No Color.

Next, change the **base height** property of your **Vegetation Burn Severity** layer by floating it over your **DEM** (again, you do not need to add the **DEM** as a layer; simply browse and point to it). To improve layer display, set the **layer offset** property to **4**, which will raise this surface 4 meters proud of your **Percent Tree Cover** surface. Don’t forget to check on the **shade effects!**

Next, use **ArcScene > Windows > Add Viewer** to open two (2) views of your terrain data. Adjust the scene in Viewer 1 to “see” the burned area from a Gatlinburg perspective; like you’re in the valley looking up into the mountains. Adjust the scene in Viewer 2 to “see” the burned area from a mountain top perspective; like you’re on the mountain and looking down into the town and valley below.

Next, use **ArcScene > View > View Settings ...** to access the properties of all of your view windows and to turn on (check on) the **Directional Arrow** for each view. The arrows will help you.

Spend some time panning, zooming, and rotating your scenes to help you develop your understanding of how the fire interacted with the terrain and, ultimately, how deeply (or lightly) the fire burned.

Question 2: Reconsider your answer to Question 1. What new information did you learn about the relationship between vegetation burn severity and the terrain? How did visualizing the terrain in 3-D change your spatial thinking process (compared to just 2-D)? (3 pts)

Save your scene document and **close ArcScene**.

TASK 3: CALCULATING THE EXTENT OF FOREST DAMAGE

We want to learn how much of the forest was affected by fire.

Specifically and first, we want to learn how much of the ground area was deeply burned or moderately burned, because these zones now lack any kind of ground-stabilizing vegetation, so the ground will be vulnerable to landsliding and debris flow events during future rainstorms.

And second, we want to know how much tree-covered area was damaged by fire. The zones where trees and the understory were completely burned will be attractive spaces for invasive species to colonize.

The answers to these questions might seem difficult to build, but they’re not if you recognize that you have most of the pieces already in your geodatabase. We know (or can easily find) the cell size property of each raster, so we can derive cell area pretty easily. We also know that each cell in the **burn severity** raster belongs completely to one severity category, so all we need to do is count the number of cells that belong to each burn severity zone.

The only problem we have is with the **percent tree cover** raster – each cell holds the percent of cell area covered by trees, and those percentages vary over space *and vary within each burn severity zone*. Re-open your map document, **BurnSeverity.mxd**, then use **Spatial Analyst Tools > Map Algebra** and the method shown below (Eq. 1) to derive **TreeArea** for each cell.

$$\text{TreeArea} = (\text{percentTreeCover} / 100.0) * \text{cellarea} \quad \text{Eq. 1}$$

where:

- **TreeArea** is the desired output raster with cells holding real tree areas measured in sq.m;
 - **percentTreeCover** is the existing input raster with cells holding percentages [0,1, ... ,99,100] where each value indicates the percent of cell area covered by tree canopy.
 - 100.0 is the percentage that represents a whole cell. It is used as a constant to convert each input percentage back to a proportion (yes, the zero on the right side of the decimal point is necessary). For example, a cell holding the percentage 45 will, when divided by 100.0, return the proportion 0.45.
- and
- **cellarea** is a constant (sq.m) and can be derived from the raster cell size (m) property.

Use **Spatial Analyst Tools > Zonal > Zonal Statistics as Table** to perform raster overlay analysis. Specifically, you want to **SUM** all the **TreeArea** values that occur inside each **Vegetation Burn Severity** zone.

Use the interactive **[Show Help >>]** window to help you learn how to create the table you need. Use the **[Tool Help >>]** window to learn more about how this type of analysis works. If you need more help, then you can check out this [video](#).

Export your new table (into either ***.txt** or ***.dbf** formats) so that you can easily open and wrangle with it in Microsoft Excel®.

Question 3a: Create a user-friendly table that highlights the amount of ground in each burn severity zone. That means showing burn severity class names and not codes. That means reporting areas in sq.km (and sq.mi in parentheses) and indicating, for each zone, the percent of total area. (5 pts)

Question 3b: How much of the affected ground area was moderately or deeply burned and, so, is likely vulnerable to erosion processes or landsliding during future storm events? (5 pts)

Question 4a: Create a user-friendly table that highlights the amount of affected forest in each burn severity zone. That means showing burn severity class names and not codes. That means reporting areas in sq.km (and sq.mi) and indicating, for each zone, the percent of total forest area. (5 pts)

Question 4b: How much of the forest was affected by fire and, so, may be vulnerable to forest pests and competing plant species? (5 pts)

Save your map document.

TASK 4: REVIEW THE OBJECTIVES YOU'VE ACHIEVED.

Congratulations, for you've accomplished the first five of six objectives! Take a moment to review the evidence you've collected over the course of Labs 5, 6 and 7. Your prior lab reports will come in handy.

Question 5: Use your map document to layout a reader-friendly map that highlights the evidence you collected while accomplishing either Objective 3, 4 or 5 (one, not all). Show your readers how the Chimney Tops 2 Fire affected people XOR property XOR forest. You have complete creative control. When you're done, export your layout as an image (in ***.tif** format and with at least 600 d.p.i.). (10 pts)

TASK 5: FINAL DELIVERABLES

Build a well-written report for Lab 7. Include your name, date, and lab title on the first page. Insert page numbers. Your report should be printed on letter size paper. Set all page margins to be 0.7” except for the left margin, which should be set to 1.2.” Use 1.5 line spacing, set the normal font face to be Bookman Antiqua, Bookman Old Style, or Georgia, and set the normal font size to be 11 points. All section headings should be left-justified and in bold. Neither headings nor captions should be orphaned.

Your *Purpose* and *Objectives* sections should be written in your own words and must address the purpose and the objectives of the entire project (not just Lab 7).

Your *Methods and Data* section will explain how you accomplished your work.

The *Results and Answers* section should include answers to the questions posed during the lab. Support your claims with evidence, examples, or supporting tables or figures.

Your *Summary* section is crucial. For this final lab report, you are required to marshal all the evidence you collected during Labs 5, 6 and 7, to sift through that evidence, and to select the best pieces that will help you answer the research question. That means you should NOT copy-n-paste every answer, every table, and every figure you put in every previous lab report: rather, it means that you need to make choices as you write an evidence-driven story. Remember, you’re the GIS Analyst – you’re the one that’s responsible for data analysis and interpreting the results. You’re the one that’s responsible for converting data into information. And, you’re the one that’s responsible for explaining the evidence and answering the research question. It is not the reader’s job to figure out what you did or what you’re trying to say. That’s your job. (20 pts)

You want your report to look professional. You want to walk away from GIS2 with tangible proof that you learned new knowledge and technical skills AND that you can communicate your knowledge, skills, and results effectively in writing. Proofreading, paying attention to details, and applying a consistent style throughout are effective ways to achieve that professional result.

As usual, all tables and figures must be numbered, have captions, and be referenced in your text. Table and figure captions should not be orphaned and, when appropriate, identify units of measure. All tables and figures must be inserted inline with your text (and not slapped onto the back). Add a line space before and after each table to buffer them away from your adjacent paragraphs. Table columns that contain text strings ought to be left-justified. Table columns that contain numbers should be right-justified with decimal points aligned (i.e., use the same level of decimal precision). Table records should be sorted in a meaningful way.