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Landscape Interpretation and Visualization Using A GIS
Geomorphology: GLG 2041

Introduction:

Geology is a discipline that relies heavily on spatial reasoning and analysis – we are often (if not usually) interested in the relationship between landforms, aquifers, structural features, etc., and their relationship within a three-dimensional environment. For example, geologists rely on a spatial understanding of: (1) topography to assess hazards associated with faults, pyroclastic flows or flood events and (2) subsurface characteristics associated with bedrock or surficial deposits to help 'visualize' the extent and quality of groundwater resources. However, geomorphologists are specifically interested in the relationship between the spatial relationships between form and process.

The goal of this lab is further develop <u>your</u> spatial visualization skills using GIS. You will use digital versions, called digital raster graphics (DRGs), of some of the maps you used in the first lab in combination with digital elevation models (DEMs), and digital orthophotos quadrangles (DOQs). You will (1) use functions within a GIS to describe the general morphology of landforms, (2) describe topography along profile lines that are "draped" over the landscape, and (3) evaluate your interpretations of these landscapes within a three-dimensional viewing environment.

Background:

DEMs are digital representations of the Earth's surface (Figure 1). They highlight topography without all the clutter of contour lines, coordinate-system lines, and map symbology. It is often easier for people to visualize spatial relationships using a combination of DEM's and DRGs (Figure 2). Similarly, DOQ's are the digital equivalent of aerial photos (Figure 3). These too can help identify features and topography so you can start to "see" the terrain on the Earth's surface.

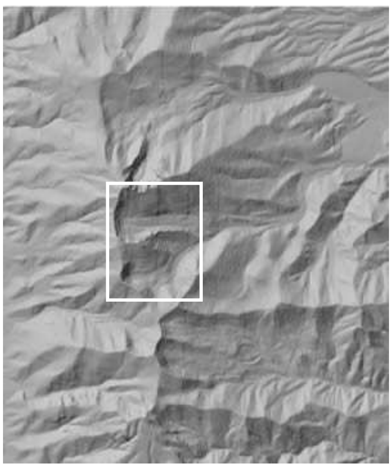

Figure 1: Great Basin National Park DEM

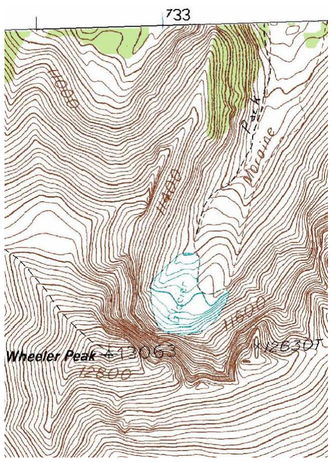

Figure 2: DRG of the inset box in Figure 1

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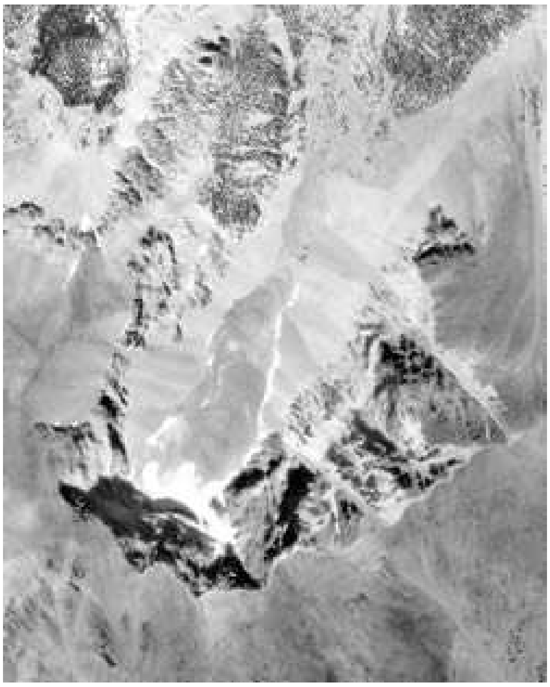


Figure 3: Aerial photo of the same area highlighted in Figure 1 and Figure 2.

Note: Some of the exercises in this lab will be similar to those you performed in a previous lab; this is intentional so that you can compare the GIS-based approach with traditional map/ruler/string/scale methods.

Exercise 1: Fish Lake, Utah

After you have opened the Fish Lake ArcGIS project, I would like you to become familiar with a few of the tools you now have access to. I am going to ask you to describe many of the same characteristics you addressed in the first lab (distance, relief, area, and gradient), only this time you are going to utilize the power of a GIS.

The first tool I want you to become familiar with is the identify tool.  Look for this icon and click on it. Now I want you to look at the left hand side of the window where you'll see three themes in the Table of Contents. In ArcGIS, themes represent different "layers" of the same location that you can turn on and off or make transparent. Make sure the Fish Lake 10M DEM is **ON**. A theme is on when it has a check in the check box, for example, in Figure 4 all layers are on except the digital orthophoto quad.

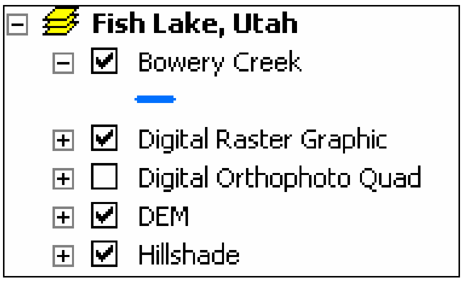
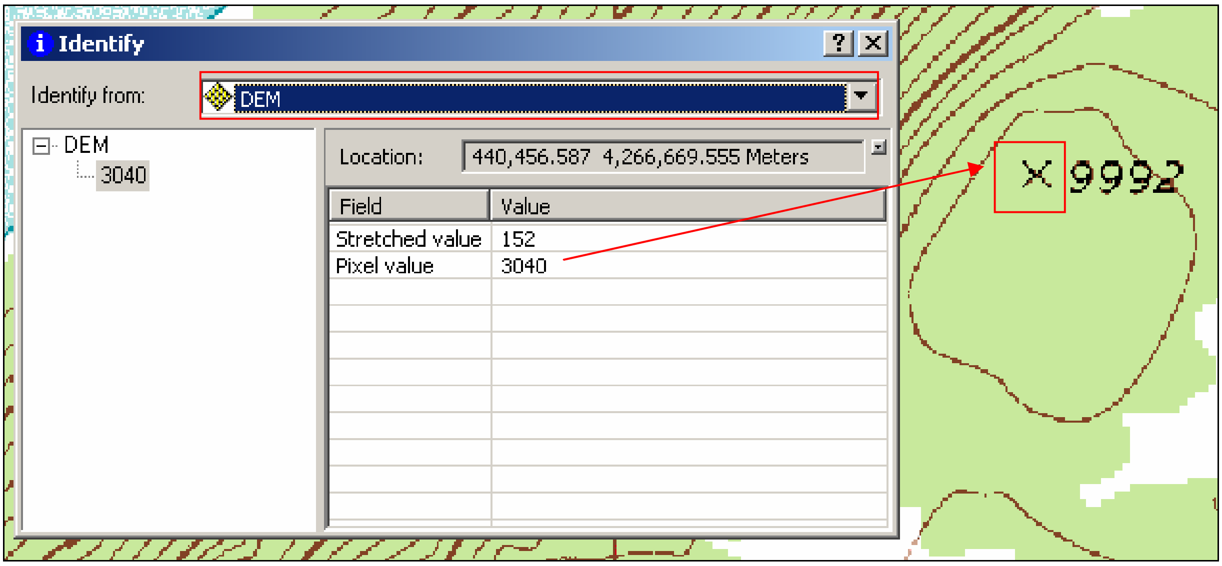
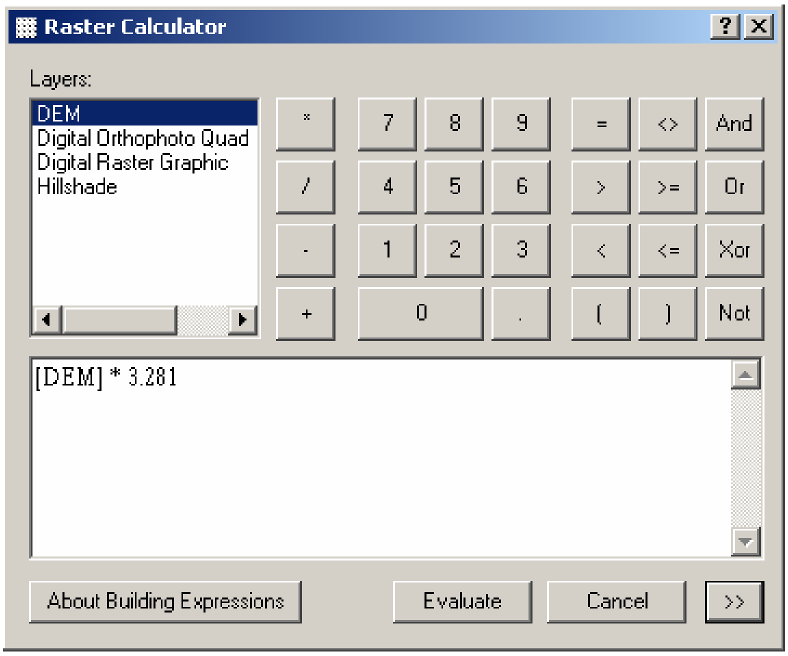


Figure 4: Example of themes that are checked and therefore visible.

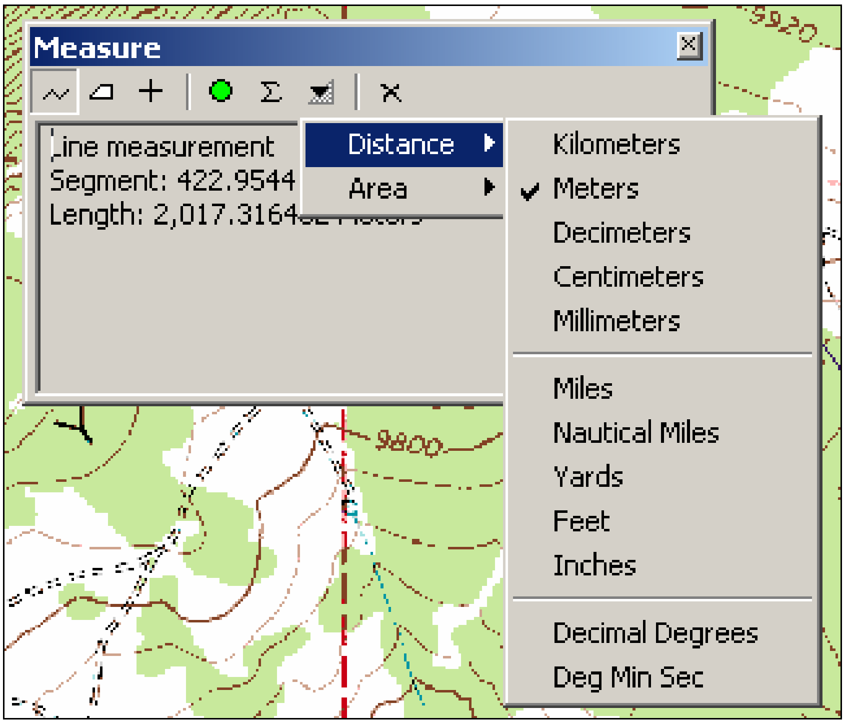
Once you are sure the DEM is active and on click on the identify tool and then click anywhere in the map view. Make sure that the DEM is selected in the identify from drop down menu similar to the interface below:



You will get a similar interface if you click anywhere within the map area. In the left hand side of the dialog box you will see the value 3040, which indicates elevation in meters and in the right side you can see the xy coordinates in UTM (easting = 440,456 and northing = 4,266,555). These are the **absolute** coordinates of the X inside the red rectangle. If you would like unit consistency between the underlying DEM and the digital topographic map, you can use the Raster Calculator to convert elevation from meters to feet by clicking: Spatial Analyst → Raster Calculator and multiplying by 3.28:



The second useful tool I want you to be aware of is the ruler tool . Look for this icon and click on it to make it active. Now click anywhere on the map, change direction and click again, notice that in the Measure Dialog Box, ArcGIS reports both the segment and total length. You can also use the ruler tool to measure area and easily change the unit of measurement.



There are a few other tools you should be aware of that will help you navigate around the various maps you're going to work with today.

The advantage of GIS is that you can have numerous layers lying on top of one another and extract information from one or more of them. For example, if you have the Fish Lake DRG turned on and the DEM active, then when you click on the map view area, the information that is returned is from the DEM, not the DRG. If this concept is not clear let me know and I'll show you what I am talking about.

Question 1: With your newly found information, what are the coordinates of the black cross hairs to the east of the elevation value 8843 located in the southern area of Fish Lake (i.e. – what are the coordinates of the actual number). **Note**: you can zoom to this location by clicking View → Bookmarks → Question 1)

Easting	Northing

Question 2: Navigate to the head of Bowery Creek (Question 2B) and the head of Jorgenson Creek (Bookmark = and 2J).

	Bowery Creek	**Jorgenson Creek**
What is elevation of the head of each stream?		
What is the elevation of the mouth of each stream?		
What is the elevation loss along each stream?		
What is the length of each stream?		
What is the approximate gradient of each stream?		

Now I want you to zoom in on the middle to lower portion of Fish Lake. Make sure both the DEM and DRG are on and that the DRG is on top of the DEM. Click the DRG on and off a couple of times to help you visualize the relationship between the contours and the topography. How does this visualization help you answer three relative compared with just using the paper topographic map?

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Question 3: Which range has the steepest side, the range to the west of Fish Lake sloping to the east, or the range to the east of Fish Lake that is sloping to the west (i.e. – Mytoga Mountains)?________________________________

Which range has the greatest relief? ________________________________

Exercise 2: Death Valley, California

Please open the Death Valley ArcGIS project and answer the following questions:

Question 4: Make sure the Trails & Start and Finish themes are turned on. Using whichever themes you find helpful, tell me which of three trails you would choose to get to the summit of the mountain and explain (in detail) why you chose this particular trail. _____________________________________
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Question 5: Turn on the outline theme. Within this approximate boundary there is a landform for which Death Valley is famous. What landform can you identify? ____

Describe the morphology of this feature (keeping mind that the outline I drew is a rough sketch of the exact boundaries). Please summarize the slope, gradient (in more than one direction), and approximate length/width using the ruler and info tools?

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Question 6: Now I want you to use ArcGIS to evaluate your assumptions and calculations regarding your answers to question 5. Please click Spatial Analyst → Surface Analysis → Slope. Using the identify tool, click within the boundary of the Outline theme to evaluate the slope of the landform. What values are reported?

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You can also use zonal statistics to evaluate the slope of this landform by clicking: Spatial Analyst → Zonal Statistics and selecting Landform as your Zone Dataset and the Slope layer as your Value Raster. What values are reported for the min, max and mean for this feature?

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Are these values similar to the values you calculated by hand in a previous lab? ____

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Exercise 4: Mc Hendry Peak, Colorado

Question 7: In your first lab you counted the number of cirques on the Mt Katahdin quad. A number of you expressed how hard it would be to count the cirques on the McHendrys Peak quad using the topographic map. Luckily, we have GIS to make our lives easier! Calculate the slope from the DEM and turn it on. Are the cirques more or less apparent? _______________

How many cirques can you identify? _____________________________

How would you describe what cirques look like to a layperson?
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Question 8: I also asked you if cirques had a preferred orientation on the Mt Katahdin and McHendrys Peak quads. Using GIS you can easily quantify the relationship between cirques and aspect. Calculate Aspect from the DEM. This new theme illustrates which direction the land surface is facing. Turn the Aspect theme off, the Slope theme on, and make the Aspect theme active. Click in the areas where you identified cirques and record the values that are returned. Using these values construct a simple histogram illustrating the preferred orientation of cirques in this region.

Question 9: Turn on the A-A' and Profile Lines themes. I want you to sketch what you think the profile along each of these lines looks like. I don't want you to measure the length, or relief, or plot a traditional profile. Just sketch what you "see" based on the DEM and DRG starting at A and ending at A'.

Line 1

Line 2

Line 3

Line 4

Line 5

Line 6

Exercise 4: Mt Katahdin, Maine

Question 10: Similar to question 9, I want you to turn on the A-A' and Profile Lines themes. I want you to sketch what you think the profile along each of these lines looks like. Remember, just sketch what you see based on the DEM and DRG starting at A and ending at A'.

Line 1

Line 2

Line 3

Line 4

Question 11: Look at the profile you drew for Line 1. What kind of glacial feature did you say this represented in the first lab? ___________________________
Is it easier to see when you draw a profile? _________________________

Question 12: Look at the profile you drew for Line 2. Is there anything different about this profile? Can you come up with a hypothesis for why this profile looks the way it does? ____

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Question 13: Compare and contrast Lines 3 and 4. What is different about the morphology of these two profiles? What is similar if anything? Can you hypothesize why these two profiles exhibit these characteristics?

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Question 14: Compare and contrast the Mc Hendry Creek DEM with the Mt Katahdin DEM. What is the biggest difference between these two themes? ______

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Which DEM would you rather interpret and describe landforms from and elaborate on your answer?

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Exercise 5: Shiprock, New Mexico

Question 20: Using the A-A' and Profile Lines themes I want you to sketch what you think the profile along each of these lines looks like. Remember, just sketch what you see based on the DEM and DRG starting at A and ending at A'.

Line 1

Line 2

Line 3

Line 4

Question 21: Looking at these profiles, what are your observations and do you have any hypothesis or hypotheses what this landform might represent?

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Is there any other evidence provided that allows you to visualize this feature more accurately? ____
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Exercise 6: Choose Your Own Adventure!!

Now I would like you to compare the results from your hand drawn sketches with 3D visualization of the profile lines using ArcScene. Pick your favorite map, or the one you think would be the most interesting in 3-dimensional space. Once you have made your selection you can open up ArcScene and load the appropriate project ending with *.sxd.

Question 22: Compare and contrast the topographic profiles you generated versus the profiles visible in 3D space. Were you close or were some of the contours difficult to visualize? ____

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I assume that it is probably easier to visualize the topography once the elevation is applied to the DRG. Does seeing these contours in a 3-dimensional environment help you visualize topography by just using contours? ____

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Question 23: What other kinds of landscape-based analyses do you think could be addressed using this type of 3-dimensional modeling?

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Reflective Essay:

Once you complete this assignment, please write a 1-2 page reflection comparing your experience between the analog and digital-based exercises. This should include any challenges, epiphanies, or observations about the way you perceive topographic relationships and if you noticed any consistent misconceptions in your approach to visualizing landforms or landscapes.