21H.S01
Greek Archaeology in the Digital Age

Lab 2: Sacred Bronze Age Views

Overview

Landscape archaeologists explore questions about how individuals react to and integrate their natural environment into their daily lives. As we have explored in class, Bronze Age cultic (i.e. religious) practices were deeply impacted by the worshipers' relationship to nature, and archaeologists are trying to unpack whether this influenced where worship or burials happened. There are a variety of ways to explore these relationships, and many analyses make use of Geographic Information Systems (GIS). This lab will utilize the Visibility tool, and demonstrate how measuring viewsheds can convey very different visual attributes.

Goals

- Gain a basic understanding of vector and raster GIS data
- Discover essential GIS functions using ArcMap: Model Builder, Visibility, Extract Values to Points, Slope, Merge Raster
- Understand how to apply viewshed analyses to quantify different visual characteristics
- Explore how archaeologists apply geospatial analyses to archaeological data in order to understand past human behavior

Turn In

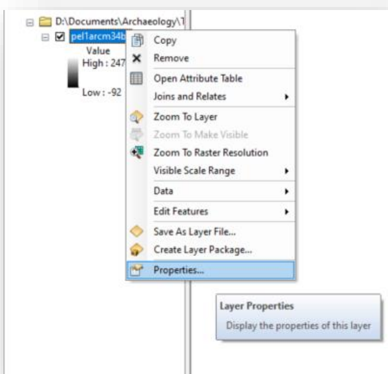
Complete all bolded questions and hand them in on Stellar by March 3rd.

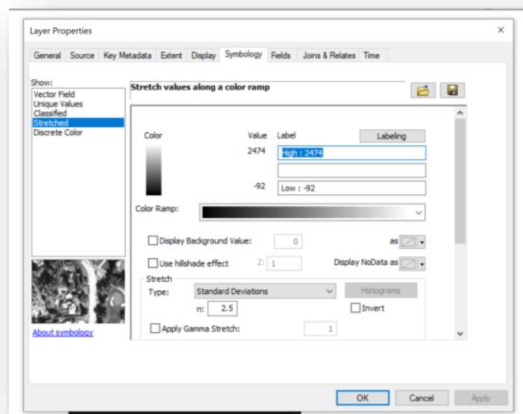
I. Getting Started

1. Download the lab dataset. Unzip/extract the folder to your desktop or other desired working space.
2. Double click on Viewshed.mxd to open it. You should have the following datasets visible: **pel1arcm34b2** (your DEM), **AH_OldShrine** (a Mycenaean tholos tomb and a 10th c BCE shrine), and **AH_Tombs** (Mycenaean tombs located near the 8th c BCE Argive Heraion sanctuary).

II. Symbology Settings

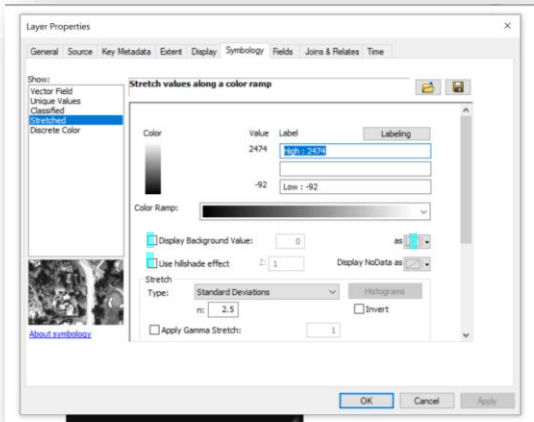
3. We can adjust the appearance of the data to suit our analyses. Right click on **pel1arcm34b2.** Navigate to *Properties* → *Symbology*





Symbology adjusts the visual appearance of the data based on values it records. **Pel1arcm34b2** already has the appropriate color symbology for a viewshed analysis. However, the color ramp is assigning a wide range of low value numbers with black, including pixels with NoData values.

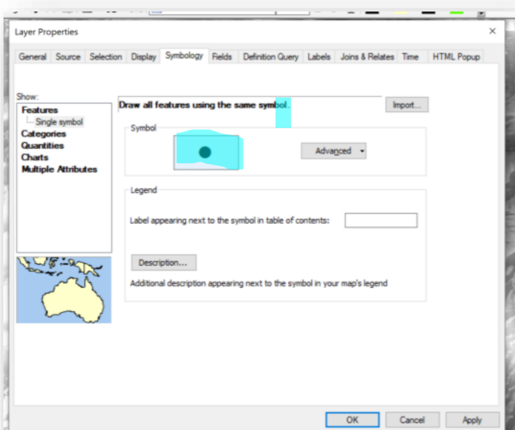
4. Check the box next to *Display Background Value* and click the dropdown *as* adjacent to it. Select a blue shade. Next, check *Use hillshade effect.* Click *OK.*

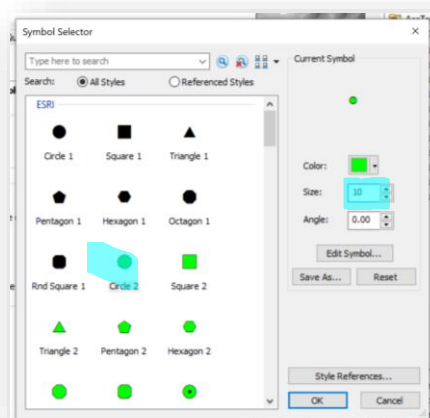


5. Using either your mouse scroll or the zoom tool (it might be docked or floating on the screen) try zooming in to your dataset. Scroll, or click and drag a box. You'll notice the effects of the hillshade setting.

6. Right click on **AH_Tombs** → *Properties* → *Symbology.* This Symbology dialogue looks slightly different because AH_Tombs is not a pixel-based dataset.

7. Click on the Symbol box. Click on the Circle 2 (lime green) option, and change the size to. Click OK.



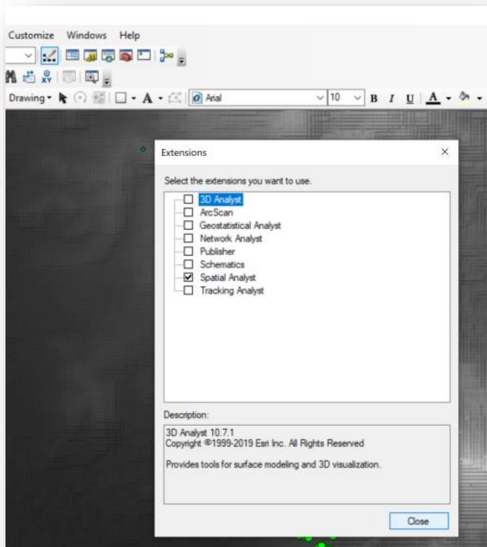


8. Right click on **AH_Tombs** and click *Zoom to Layer.* You should see the points on your screen. Feel free to zoom out a bit.

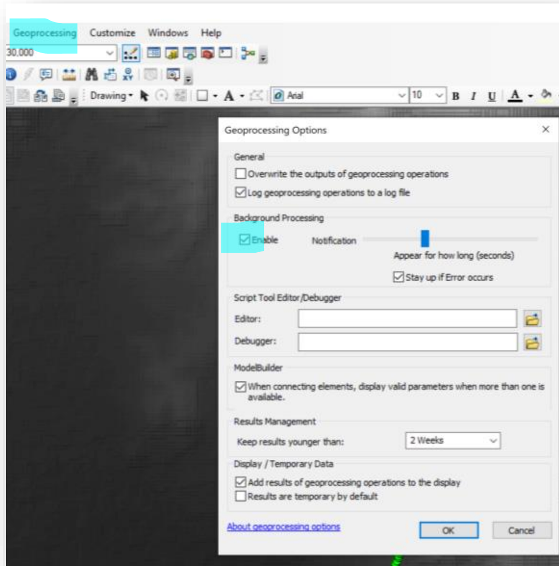
9. Change the symbology for **AH_OldShrine** as well – choose whatever you like.

III. Using the Visibility Tool

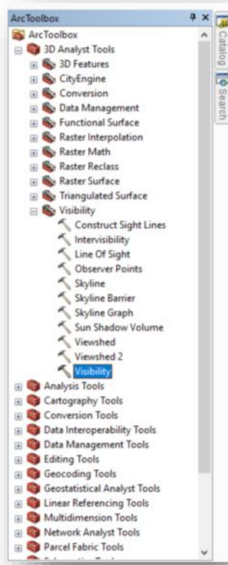
10. On the top of the screen, click *Customize* → *Extensions.* Make sure that the box next to *Spatial Analyst* is ticked and click OK.



11. Click *Geoprocessing* → *Geoprocessing Options.* Tick *Enable* under Background Processing and click OK. Ticking this makes the toolkit progress visible to you, though it also slows down the computation. It's a better option for beginners.



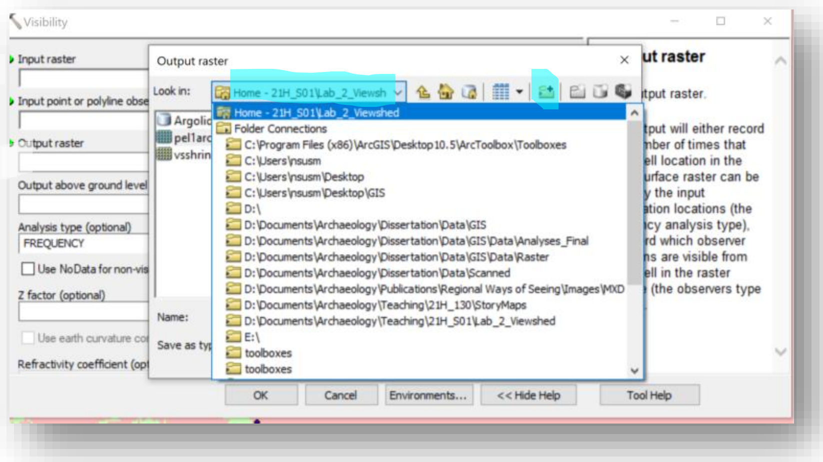
12. Find the Toolbox. It might be docked somewhere, or already open on the side of your screen. Once you locate and open it (just click X1), navigate to *3D Analyst Tools* → *Visibility* → *Visibility.* Double click to open the tool.



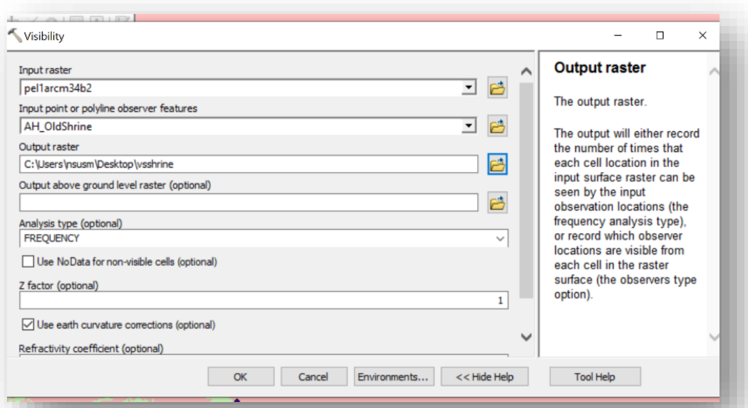
13. Through the toolbox, ArcMap provides an easy-to-use dialogue. Note that you can alternatively run these tools using Python.

14. Select **pel1arcm34b2** as your *Input Raster* using the dropdown arrow. Select **AH_OldShrine** as the *Input Point*.

15. Your *Output Raster* is the file you will produce. Click on the folder and try to find your working folder. Try first by selecting the dropdown arrow, and either 1) directly finding the folder or 2) finding the desktop or C drive and clicking through. If not, click the *Connect to folder* icon and find it that way. Once in the folder, name your output **vsshrine**.



16. Check the box next to *Use earth curvature corrections.* Scroll through the tool settings and expand *Observer Parameters.* In *Observer Offset*, enter a value of 1.65.



This parameter will gauge visibility based on the observers being 1.65 meters tall (about 5’ 4”); there is no need to input the unit of measurement, because this was already entered during data preprocessing. Without entering an observer offset, the visibility tool would assume the observers had no height.

Q1: The Observer Offset value was not chosen at random. What archaeological data do you think I could I have referenced to choose an average height parameter? Considering that the Visibility tool was not initially designed with archaeological data in mind, do you think there are any limitations with respect to applying/not applying the Observer Offset Value?

17. Check your settings and click OK. On the bottom righthand of your screen, you should see a running "Visibility…" message in blue.

    Input raster: pel1arcm34b2
    Input point features: AH_OldShrine
    Output: vsshrine (shared to your working folder on the desktop)
    Analysis Type: Frequency
    Use Earth Curvature Corrections
    Observer offset: 1.65 m

18. After about 5 minutes, the tool should finish running. There should be a new raster dataset visible that is colored pink and lime green.

Q2: What did the analysis produce? Describe vsshrine.

19. *Navigate to 3D Analyst → Raster Surface → Slope.* Your *Input Raster* will be **pel1arcm34b2**. Save the *Output Raster* to your Data folder, and name it **slope.** Leave everything set to default, and click OK.

20. Using the *Table of Contents,* drag **vsssbrine** on top of **slope**. In the *Table of Contents,* left click on the green box labeled *Visible → Properties → Color is Null.*

Save your map!

Q3: On this hillside, there was a Mycenaean tholos tomb built (15th c BCE). In the 10th c BCE, Greeks created a shrine close to the tholos. AH_OldShrine.shp marks both locations. The larger cemetery (AH_Tombs.shp) was founded about a century after the tholos tomb (14th – 13th c BCE). Archaeologists believe that the individuals who used the shrine wanted to maintain a respectful – but visible – distance from their Bronze Age predecessors. In other words, they made a shrine nearby the tholos and cemetery, but not too close – and they made sure they could see both of them. This hypothesis is based on many comparative sites in the region, including Mycenae, Asine, Argos, and Berbati.

Your viewshed does not entirely support this hypothesis – why? Does this mean that the Argive Heraion site completely dismantles this hypothesis about Protogeometric (c. 10th – 9th c BCE) religious practices? What are some other considerations which need to be made? Some things to think about:

- **Step 22**
- **How someone would use a sanctuary – think about your own visits to churches, temples, or any sort of historical monument. How did you move through the space?**
- **The elevation dataset. The data has a resolution of 30 m, meaning that each pixel's elevation value is an average of a 30 m square area. How does this impact results?**

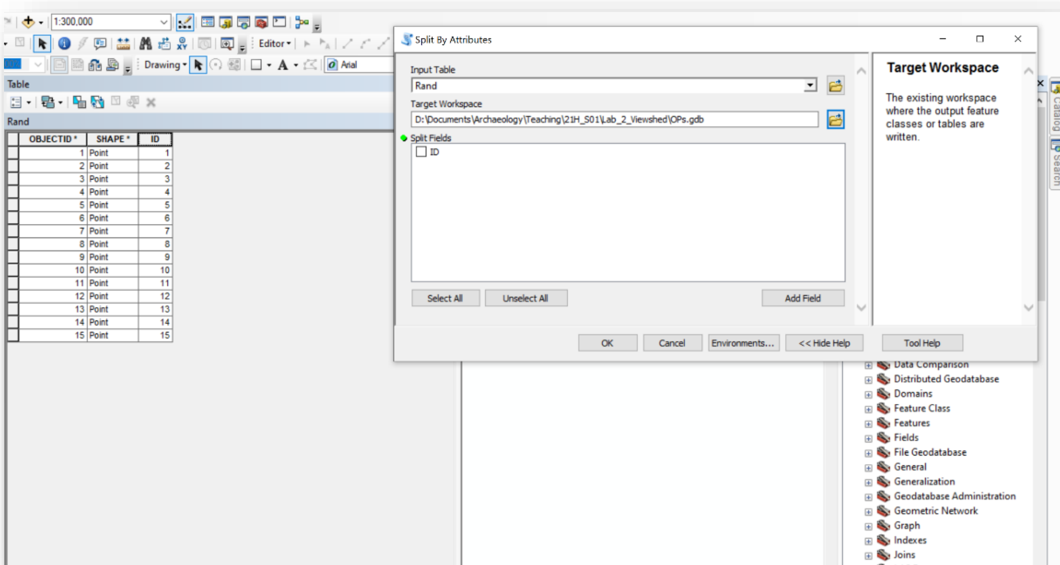
Q4: Archaeologists can easily get access to visit and photograph these sites in person. Why should we bother measuring visibility if some of these characteristics are observable? What does the quantitative data enable us to do? Think on a broad level.

IV. Visibility

21. Open the Visibility MXD. You should have these files in the *Table of Contents:* **Rand** (a random set of observer points), **Extent** (a polygonal extent of the study area), **PeakSanc** (peak sanctuaries in the study area), and **pel1arcm34b2.**

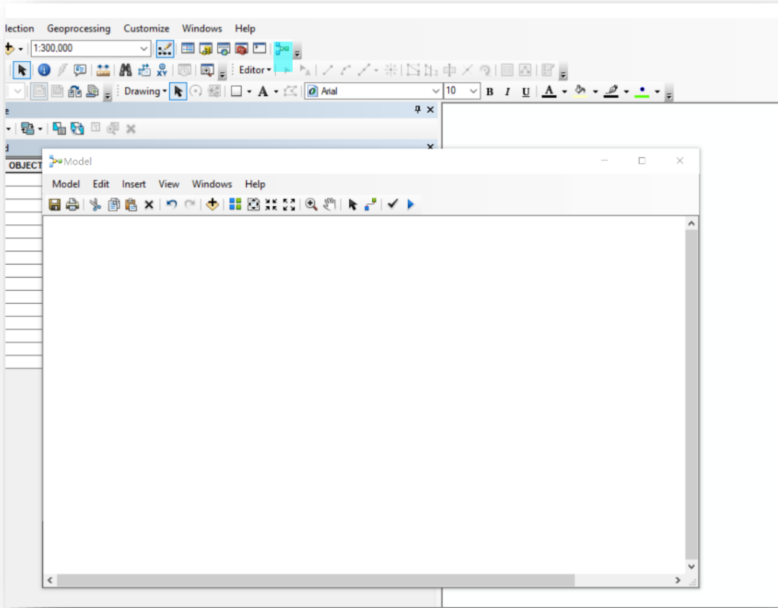
22. In the toolbox, find *Data Management* → *Raster* → *Raster Processing* → *Clip.* Set **pel1arcm34b2** as your input, **Extent** as your extent. Name your output **argdem** and save it to your data folder. Do not change any other parameters. Click OK.

23. In the toolbox, navigate to *Analysis Tools* → *Extract* → *Split by Attributes.* Select **Rand** as the *Input Table* and set your target workspace to OP.gdb (this is an empty geodatabase already located in your data folder). Click on ID as the *Split Fields.* Click OK.

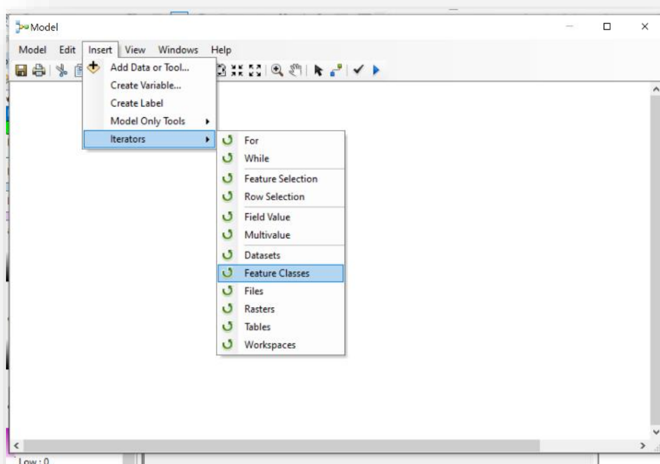


Split by Attributes explodes **Rand** into multiple shapefiles – one shapefile per record. In ArcCatalog, you can open OP.gdb to see them.

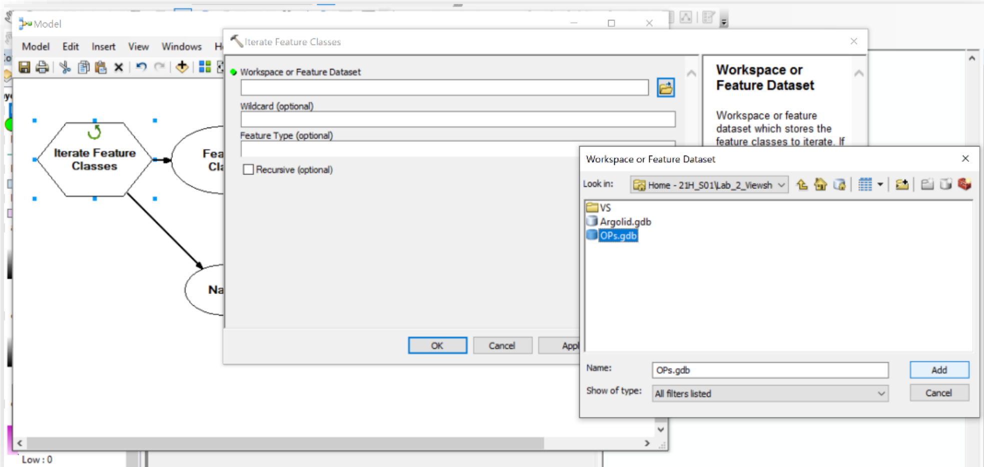
24. Open *Model Builder* in ArcMap. Model Builder is docked at the top of your screen. Model Builder is a space for creating batch work without bothering with codes.



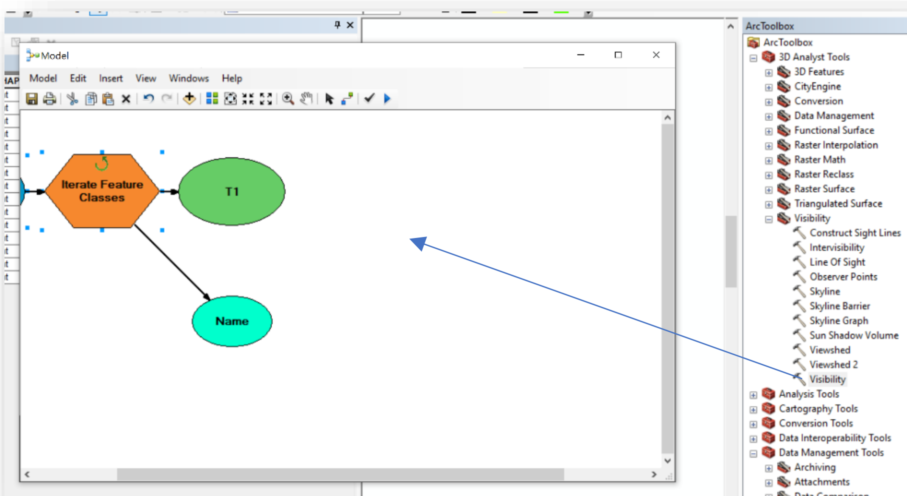
25. Navigate to *Insert* → *Iterators* → *Feature Classes.* The Iterator tool will be added to the Model Builder workspace. Iterator tells ArcMap to loop through a dataset multiple times, and perform the same series of steps on each. We've created a bunch of observer points in the previous steps, and saved them into a separate geodatabase; we will be directing the iterator to work only with these points. Notice that the tool's polygons are all white in the Model Builder workspace. This is because no parameters are set.



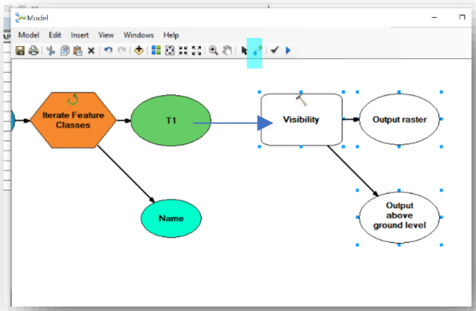
26. Select the **OPs.gdb** as the target workspace. Leave all other settings alone and click OK. Notice that the Iterator tool is now colored in the workspace.

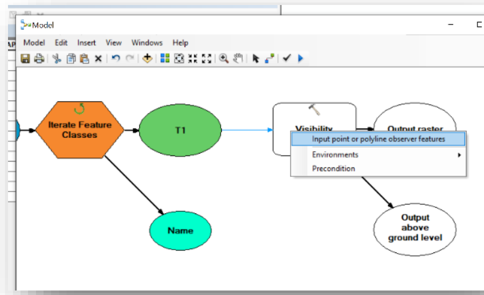


27. Find your ArcMap toolbox, and navigate to the same *Visibility* tool we used in the previous section. Highlight it and drag it into the Model Builder workspace. It should appear in the workspace and be uncolored.



28. Click on the *Connect* tool at the top of the screen. Your cursor is now a wand. Link **T1** with *Visibility.* Select the *Input Point…* option.



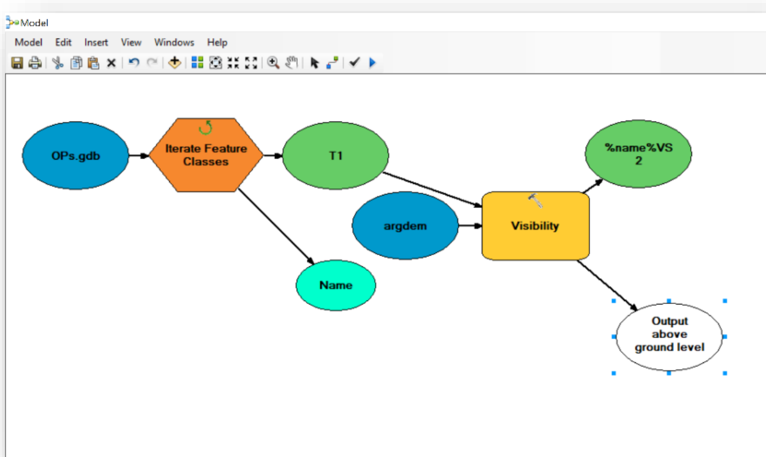


29. Click on *Visibility.* Select **argdem** as the *Input Raster.* Notice that the observer points are already set; you made this connection in the previous step. Store the *Output Raster* in the **VS subfolder** (this is a premade empty folder, located inside of your **Data** folder). Name the output **%name%vs**

    Select the Earth Curvature option, and set the observer offset to 1.65

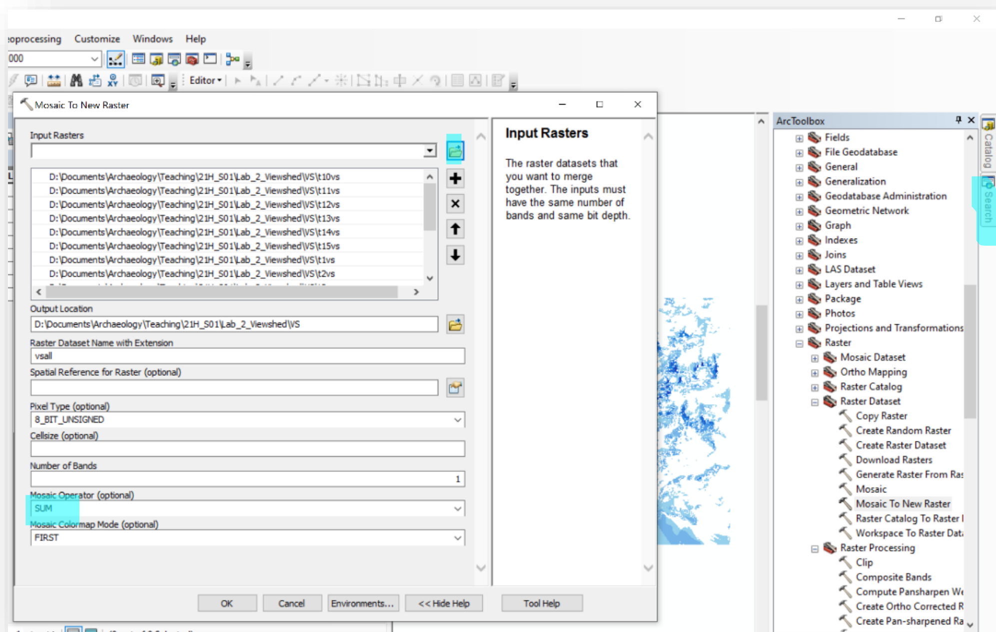
    Note: %name% is a tag for iterator tools. This tag tells ArcMap to name every output viewshed the same name as the observer point – we've also added the suffix "vs". So, as ArcMap goes through **OP.gdb** and creates a viewshed per each feature class, it will produce viewsheds: ID1vs, ID2vs, etc.

30. Click OK. Your model builder should be colored, except for the *Above Ground Level* polygon – we aren't using this optional tool.



31. At the top of the screen, select *Model* → *Run.* The model will run for about 15 minutes. When it is done, you should have 15 viewsheds inside the VS folder.

32. Using the tool search box (docked on the side or top of the screen), type *Mosaic to New Raster*. Double click on the search result. Alternatively, you can access this tool in the toolbox → *Raster* → *Raster Dataset* → *Mosaic to New Raster.* In the *Input Raster* folder, select all of the viewsheds in the VS folder. Use the same VS subfolder as the *Output location*, and name the output file **vsall.** Use a *Mosaic Operator* of SUM.

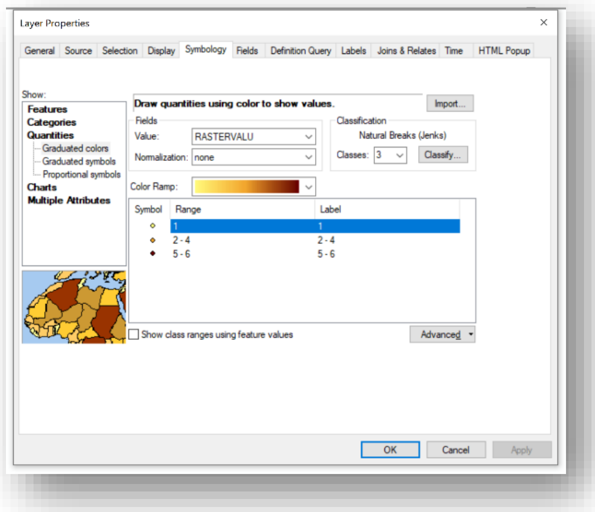


Q4: Think about what you've just done. What does vsall represent? Hint – compare the observer inputs from Section #1 with this analysis. Analysis #1 used a shapefile recording the locations of graves, and this can translate to observers standing at those graves. All of those observers are inside <u>one</u> shapefile. Analysis #2 creates multiple viewsheds, each from the perspective of an observer placed at a random location, and then merged these together. What's the difference? Hint: if you're really stuck, reread Dederix!

33. Use the Search toolbar again and find *Extract Values to Points.* Open the tool (make sure you select the *Extract Values* and not *Extract Multivalues)*. Your *Input Features* should be **PeakSanc** and your *Input Raster* is **vsall.** Direct your *Output Point Features* to save in **Visibility.gdb** and name the file **PeakSancVal.** Click OK and run the tool.

Open the attribute table of **PeakSancVal.** This shapefile copies the records from PeakSanc, but also records its intersecting values from **PeakSanc.** This is recorded in the field *RASTERVALU.*

34. Open the *Symbology* of **PeakSancVal.** Choose *Graduated Colors.* Under *Fields →* *RASTERVALU.* Choose a graduated (e.g. light to dark) color ramp. You can make the points larger by clicking on each one.



35. Turn off all layers in the map, except for **pel1arcm34b2** and **PeakSancVal.** Make sure the peak sanctuaries are visible (i.e. are on top). Save your map!

Q5: What is the result of this analysis? What does PeakSancVal tell you?

Final Note: We used 15 observer points in order to make the visibility computation more manageable. For a statistically significant sampling, I would place observers 50 – 200 meters apart for this region. This would mean using several thousand observer points, and in turn, producing several thousand viewsheds. In most cases, a shared computing cluster or similar is required. I have placed an additional raster dataset in your Data folder (**cvsos**) so you can see the difference in precision. This was done for about a 3000 square km region, and OPs were placed 50 m apart. It took about 40 hours to complete.