Earth Imagery at Work MOOC

Exercise

Power Line Corridor Analysis with ArcGIS Pro

Section 5 Exercise 1

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esri

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Power Line Corridor Analysis with ArcGIS Pro

Instructions

Use this guide and ArcGIS Pro to reproduce the results of the exercise on your own.

Note: The version of ArcGIS Pro that you are using for this course may produce slightly different results from the screenshots you see in the course materials.

Time to complete

Approximately 30-35 minutes.

Software requirements

ArcGIS Pro version 2.0.1

Introduction

In this section's lecture, you learned about how utility employees rely on imagery to increase efficiency in their electric grids. One of the primary metrics that these employees use to monitor their efficacy is the average outage duration for each customer, commonly referred to as a SAIDI score. In the United States, the System Average Interruption Duration Index (SAIDI) score typically falls around 120 minutes, but it varies from region to region. The goal of utilities is to provide reliable power, and utility companies spend millions of dollars to work on improving their SAIDI scores.

This exercise looks at how vegetation can encroach upon power lines. This is of particular concern to utility companies because that vegetation poses a threat when storms pass through the area. Storms can easily topple trees, which then fall into power lines and cause outages.

Exercise scenario

In this scenario, you are working as an analyst for a utility company. You have high-resolution, color infrared imagery, as well as a 3D point cloud that was collected at the same time. You need to classify the imagery to identify vegetation and then classify the point cloud to see how tall that vegetation is.

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Earth Imagery at Work

Using ArcGIS Pro and Imagery for Corridor Management

Before beginning this exercise, you will download a project package and a ZIP file containing the data needed for this exercise. A project package is a file that contains all maps and the data referenced by their layers, as well as folder connections, toolboxes, geoprocessing history, and attachments.

Step 1: Download the Power_Line_Corridor_Analysis project package

The project package can be found in the *Earth Imagery at Work* organization in ArcGIS Online.

a. Open a new Internet browser tab or window.

b. Go to www.arcgis.com and sign in to ArcGIS Online using the credentials determined at the start of this course.

   Note: The Section 1 Exercise 1 PDF explains how to determine your ArcGIS Online credentials (username and password) for this course. If you have trouble signing in, email gistraining@esri.com for assistance.

c. Click the Section_5_Power_Line_Corridor_Analysis project package to go to the page in the Earth Imagery at Work organization in ArcGIS Online where the ArcGIS Pro package is hosted.

d. Click Download to download the package file.

   Note: This project package is approximately 271MB in size and may take some time to download.

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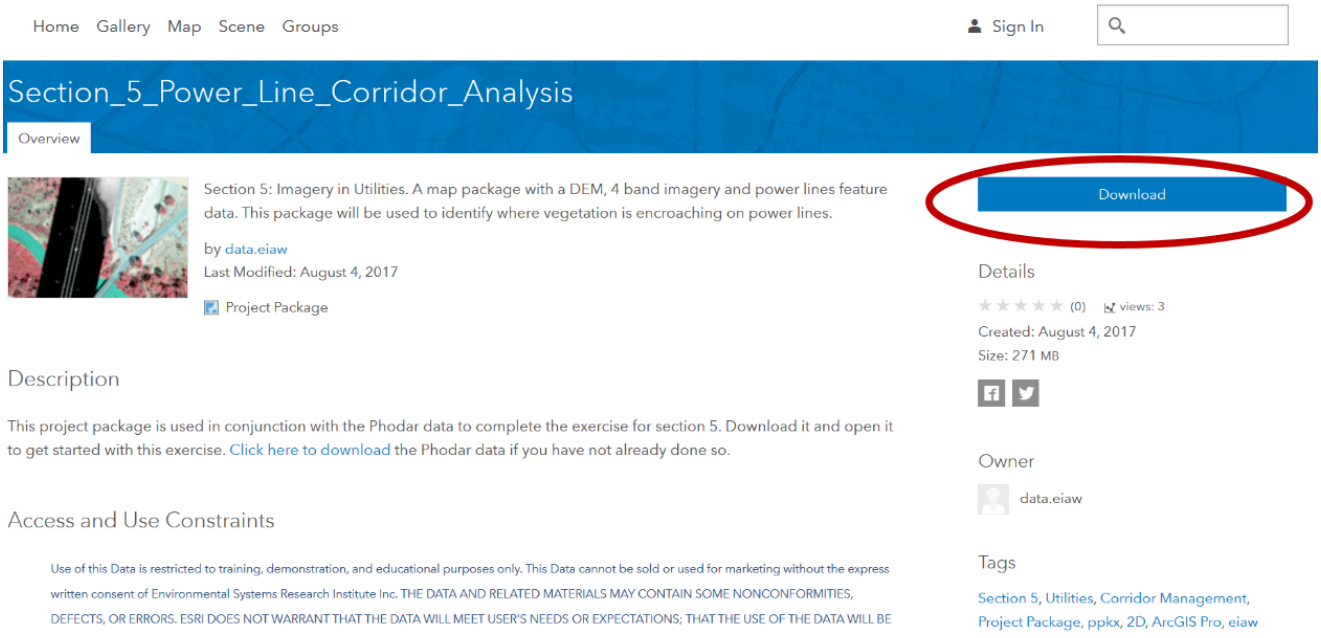

When the download is complete, ArcGIS Pro will automatically launch and the project will load.

> *Note: If ArcGIS Pro does not automatically launch after the download is complete, you can manually open the project package. In the Downloads folder on your computer, right-click the file, and from the drop-down list, click Open With. In the Open With dialog box, choose ArcGIS Pro.*

If you have not already done so, you will need to sign in to ArcGIS Pro using your ArcGIS account credentials.

> *Note: If you need to review how to sign in to ArcGIS Pro, refer to the Download and Install ArcGIS Pro exercise in Section 1. If you have trouble signing in, email gistraining@esri.com for assistance.*

Next, you will download Phodar data, which is photogrammetric detection and ranging data that will be used to measure the height of the tree canopies.

Step 2: Download the Section 5 Power Line Corridor Analysis Phodar Data ZIP file

The Phodar data ZIP file can be found in the Earth Imagery at Work organization in ArcGIS Online.

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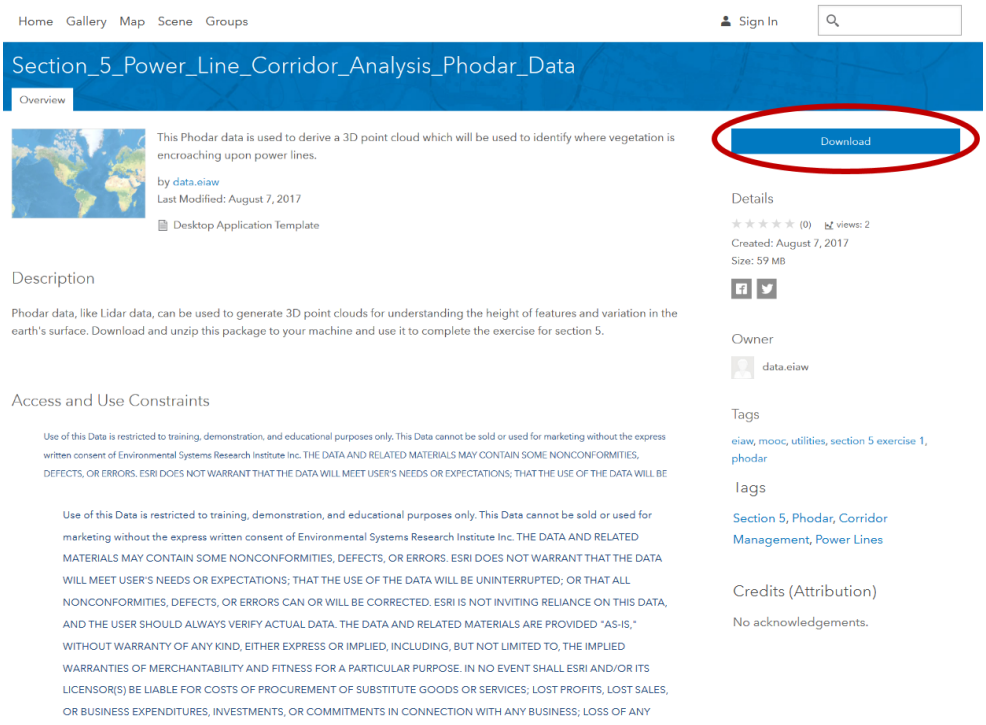
a. Click the Section 5 Power Line Corridor Analysis Phodar Data ZIP file to go to the page in the Earth Imagery at Work organization in ArcGIS Online where the Phodar data ZIP file is hosted.

b. Click Download to download the ZIP file.

Note: This ZIP file is approximately 55MB in size and may take some time to download.



Depending on your web browser, you may be prompted to choose where the file will be downloaded. Most browsers download to your computer's Downloads folder by default.

c. When the download is finished, go to your Downloads folder and unzip the Section_5_Power_Line_Corridor_Analysis_Phodar_Data ZIP file to your desktop.

You will see the three Phodar data files that you will use in this exercise: Phodar-3inch.las, Phodar-3inch.lasd, and Phodar-3inch.lasx.

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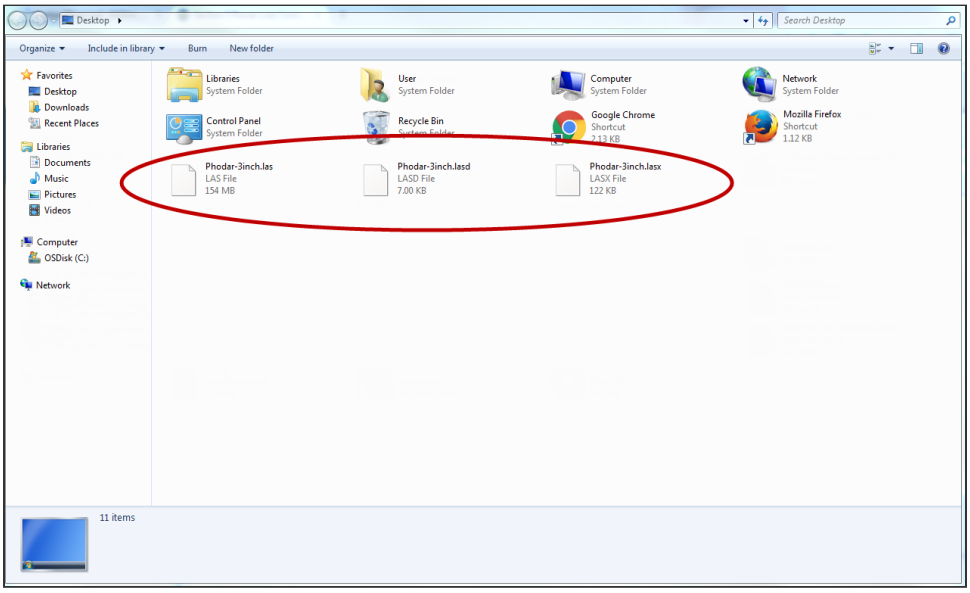
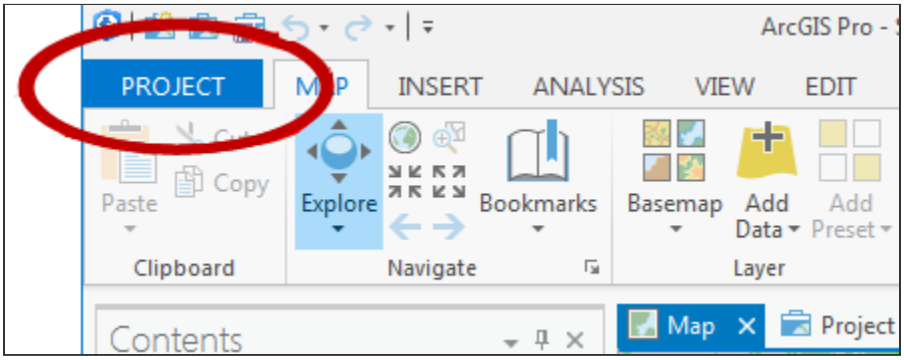


In this exercise, you will be using specialized analysis tools and functionality in ArcGIS Pro. Next, you will verify that the 3D Analyst and Spatial Analyst extensions are available and turned on to ensure that you have access to these tools.

d. In ArcGIS Pro, on the ribbon, click Project.



e. From the options list, choose Licensing.

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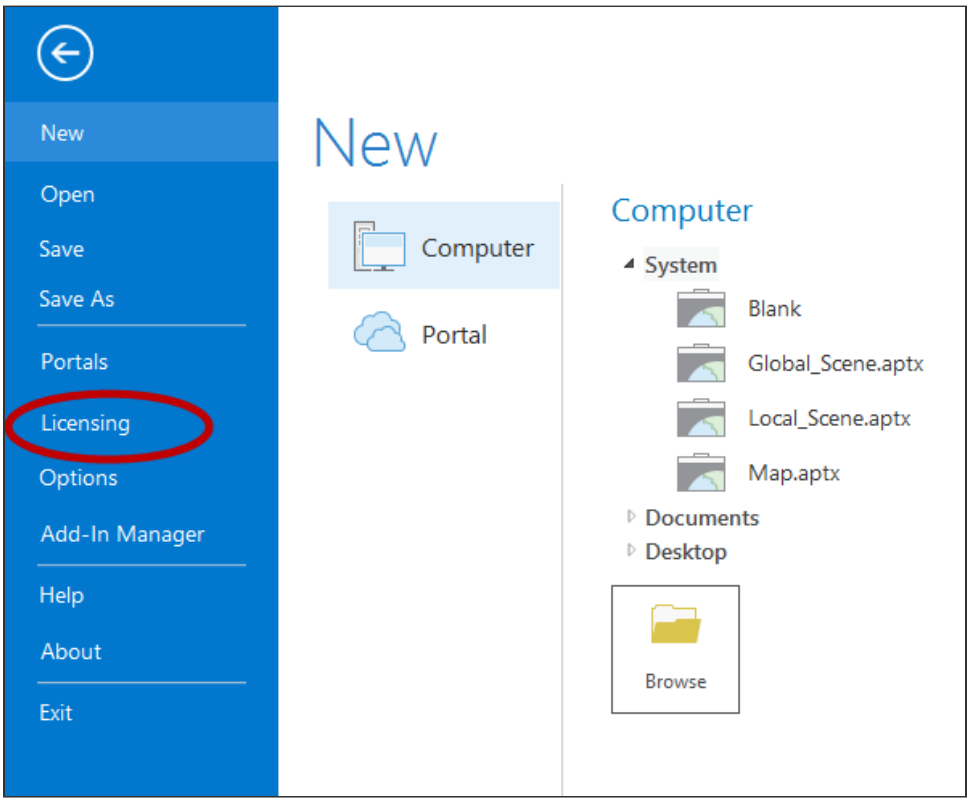

f In the Licensing window, under Esri Extensions, verify that the 3D Analyst and Spatial Analyst extensions are licensed.

If you are using your ArcGIS account for the *Earth Imagery at Work* course, you will have access to these extensions. If you are using your own account and don't have access, you will either have to speak to your account administrator or switch over to the account for this course. Contatct GISTraining@esri.com with any questions.

g Click the Back button to return to the main ArcGIS Pro window.

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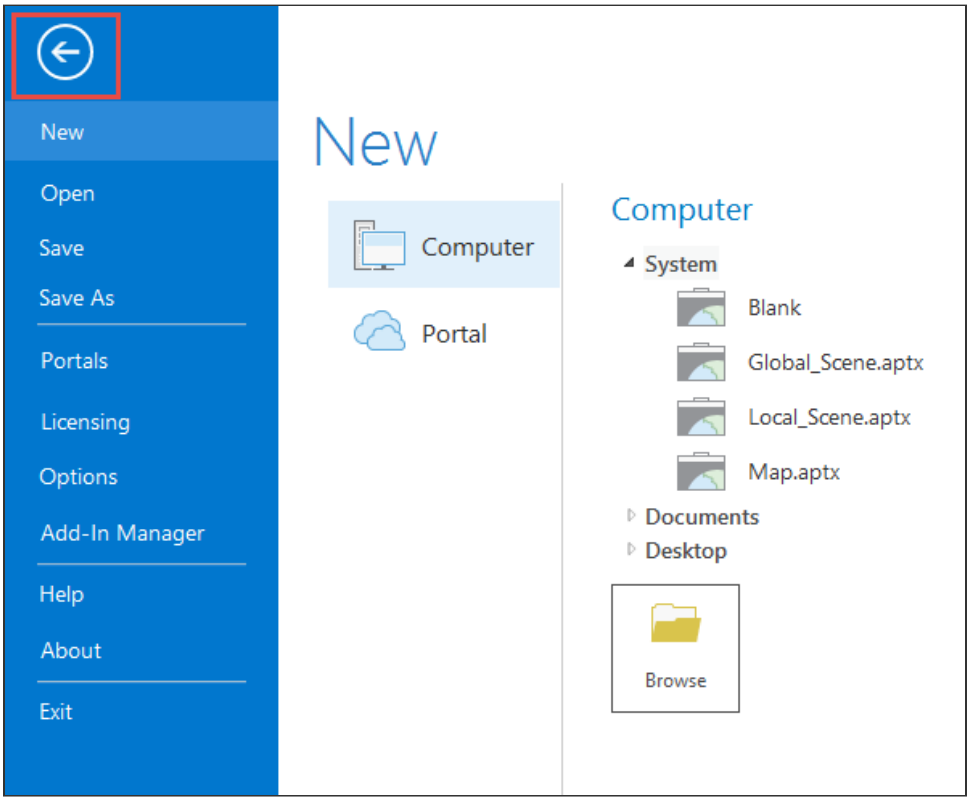
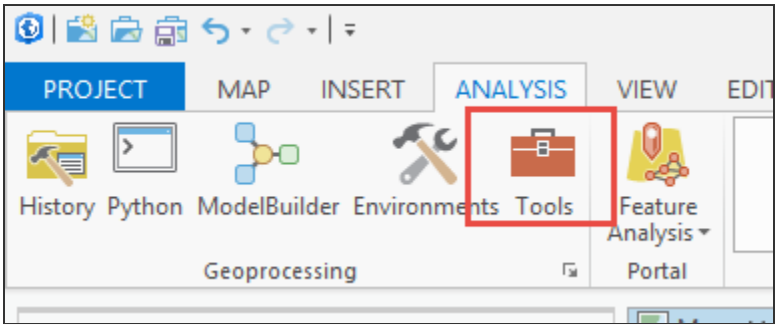


Next, you will set up the Phodar files. In this version of ArcGIS Pro, creating a map package with LAS datasets is not supported yet, which is why you must perform this extra step.

Step 3: Create an LAS dataset

a. From the main ArcGIS Pro window, click the Analysis tab, and then open the Geoprocessing Tools pane by clicking the red toolbox (Tools).



b. In the search box, type **create las dataset**, and then open that tool.

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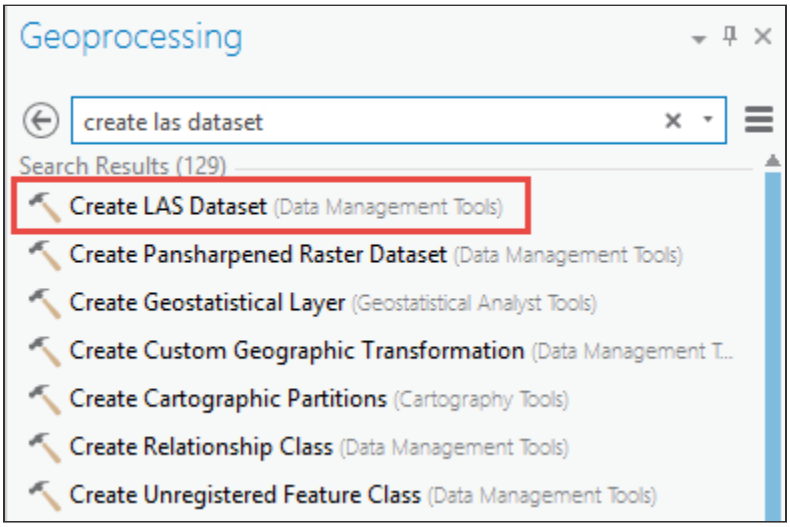

c. In the Create LAS Dataset pane, on the Parameters tab, for Input Files, browse to the folder where you unzipped the Phodar-3inch.las file (it should look like the image below).

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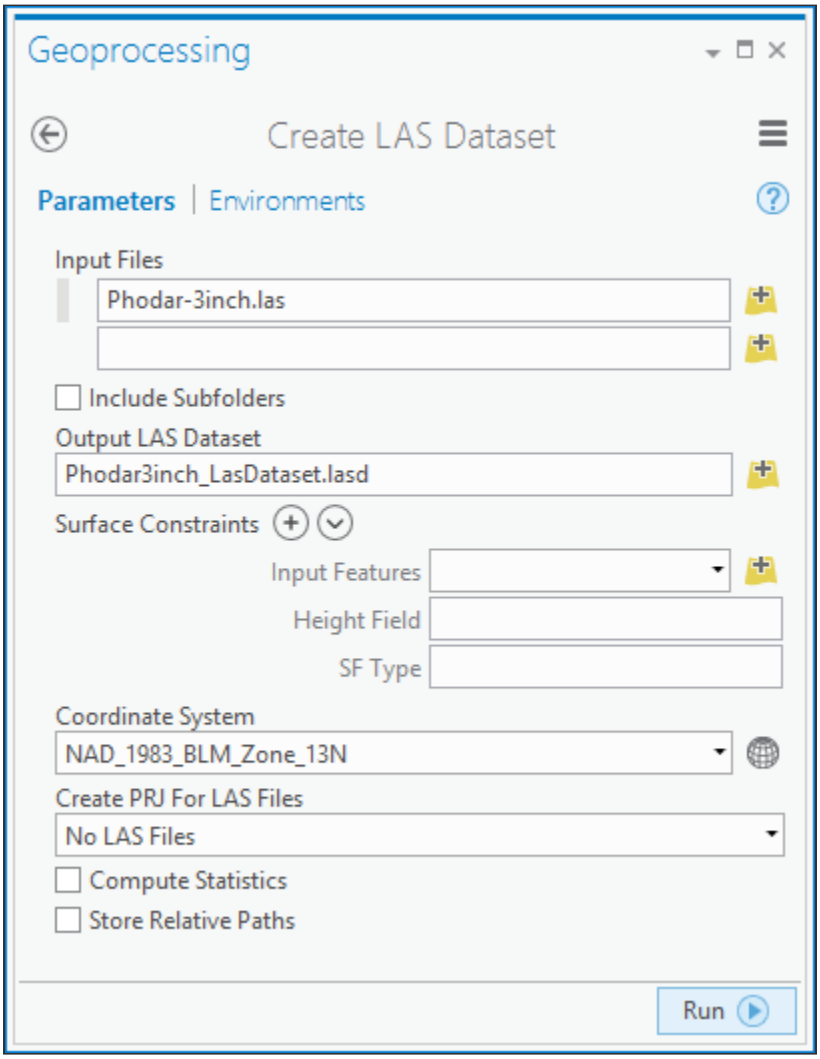

d. Click Run to execute the tool.

Now that you have the map set up, you will dive into the workflow. There are a few steps involved. You will classify the imagery to identify where the vegetation is. Then, you will use the 3D point cloud to identify how tall the vegetation is. Where there is vegetation that is too close to the power lines in terms of proximity and height, you will flag it for pruning or removal.

Step 4: Use a polygon feature class to classify a 3D point cloud

In this step, you will use four-band orthoimagery and a 3D point cloud to derive a polygon feature class representing areas of low, medium, and high vegetation. You can then use that polygon feature class to classify the 3D point cloud.

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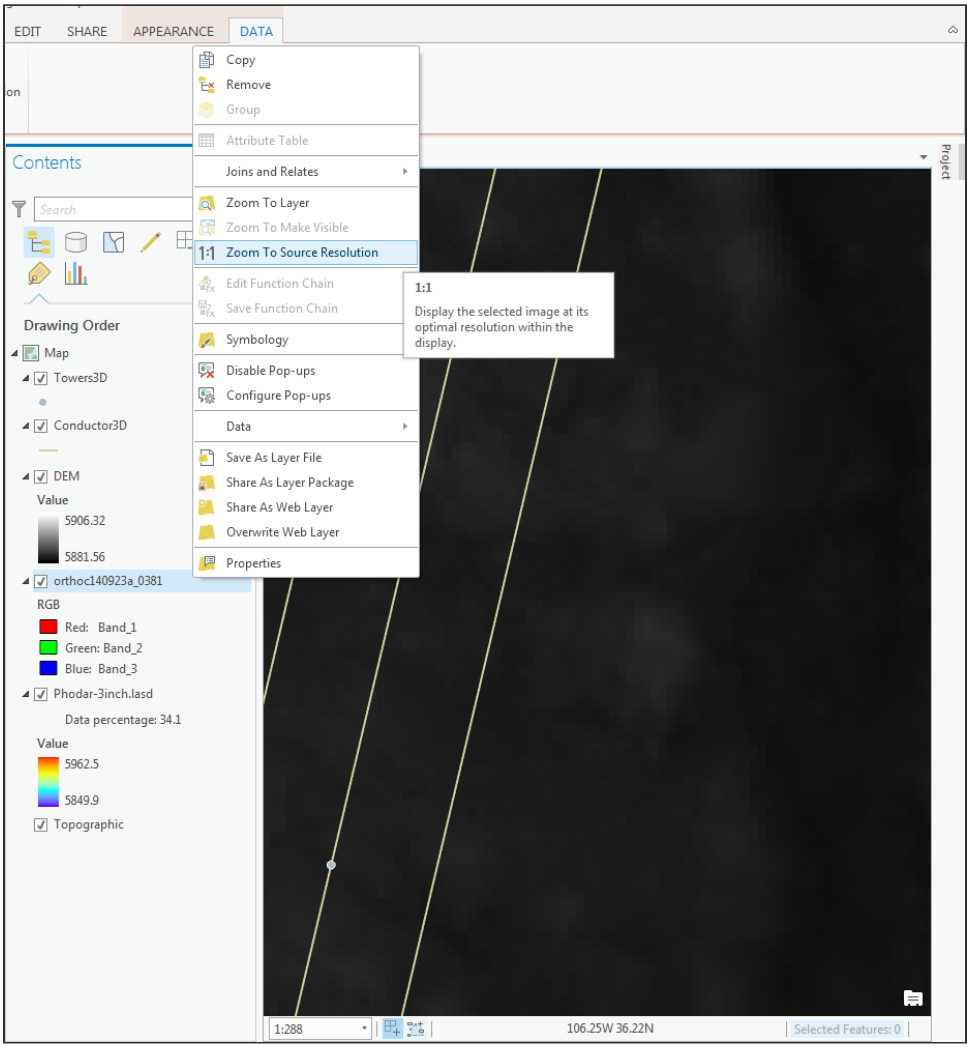
a. In the Contents pane, right-click the orthoc140923a_0381 imagery layer and choose Zoom To Source Resolution.



b. From the Contents pane, click the orthoc140923a_0381 image to select it.

When you select this image, you will see the Raster Layer tab appear on the ribbon.

c. From the Imagery tab, open the Classification Tools drop-down list.

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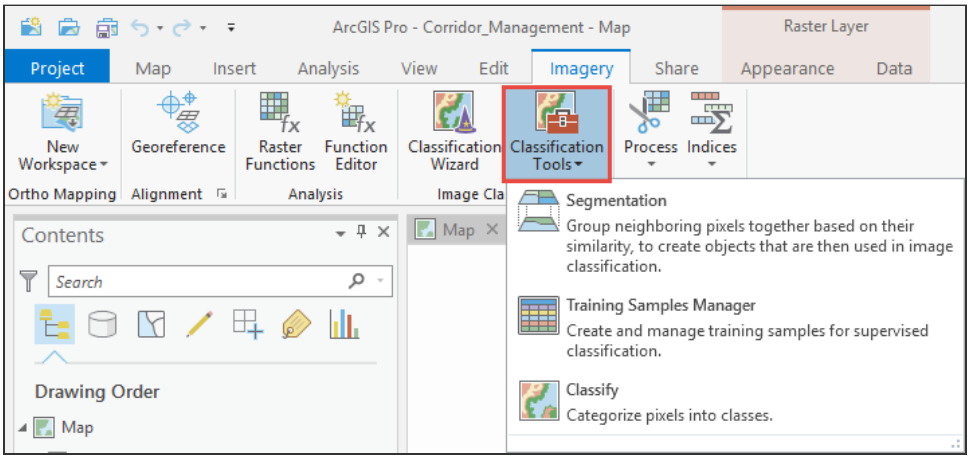
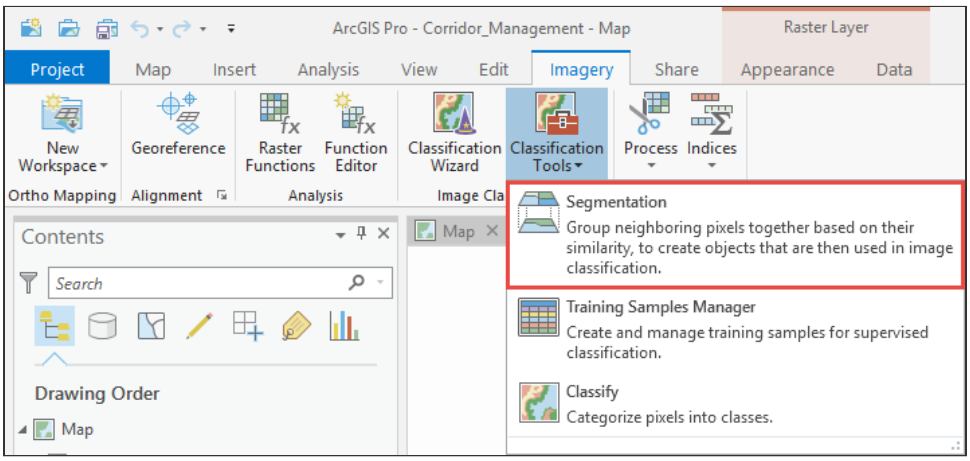


Here, you will find all the tools to classify imagery. Your goal is to segment the image to identify areas of vegetation.

Segmentation is a process that attempts to group pixels together that are neighboring and have a similar color. This is an important step in classification. Without it, you can end up with a salt-and-pepper effect because a pixel may be mixed with more than one feature, like soil and grass. When you use segmentation to identify these objects, they tend to more closely resemble the features on the ground, and the result is a cleaner classified map.

d From the Classification Tools drop-down list, open the Segmentation tool.



Segmentation is a two-step process and can take some time to run. It's also an iterative process, where you want to see your result before progressing to the next step. You'll be using a preview layer that processes the imagery on-the-fly before you run the tool to save the output. This will show up in the Contents pane as Preview_Segmented. The preview layer only processes the part of the imagery that is on the screen, so you must be at the source

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resolution to obtain an accurate preview. As you zoom around the image to check the segmented image, it will process the part of the imagery that you have moved to.

There are two parameters that really control how the segmented image is created: spectral detail and spatial detail.

Spectral detail refers to how similar in color neighboring pixels need to be in order to be grouped into an object. A higher value is appropriate when you have features that you want to classify separately but have somewhat similar spectral characteristics. Smaller values create spectrally smoother outputs. For example, with higher spectral detail in a forested scene, you will be able to have greater discrimination between the different tree species.

Spatial detail refers to the proximity between features in your imagery. A higher value is appropriate for a scene where your features of interest are small and clustered together. Smaller values create spatially smoother outputs. For example, in an urban scene, you could classify an impervious surface using a smaller spatial detail, or you could classify buildings and roads as separate classes using a higher spatial detail.

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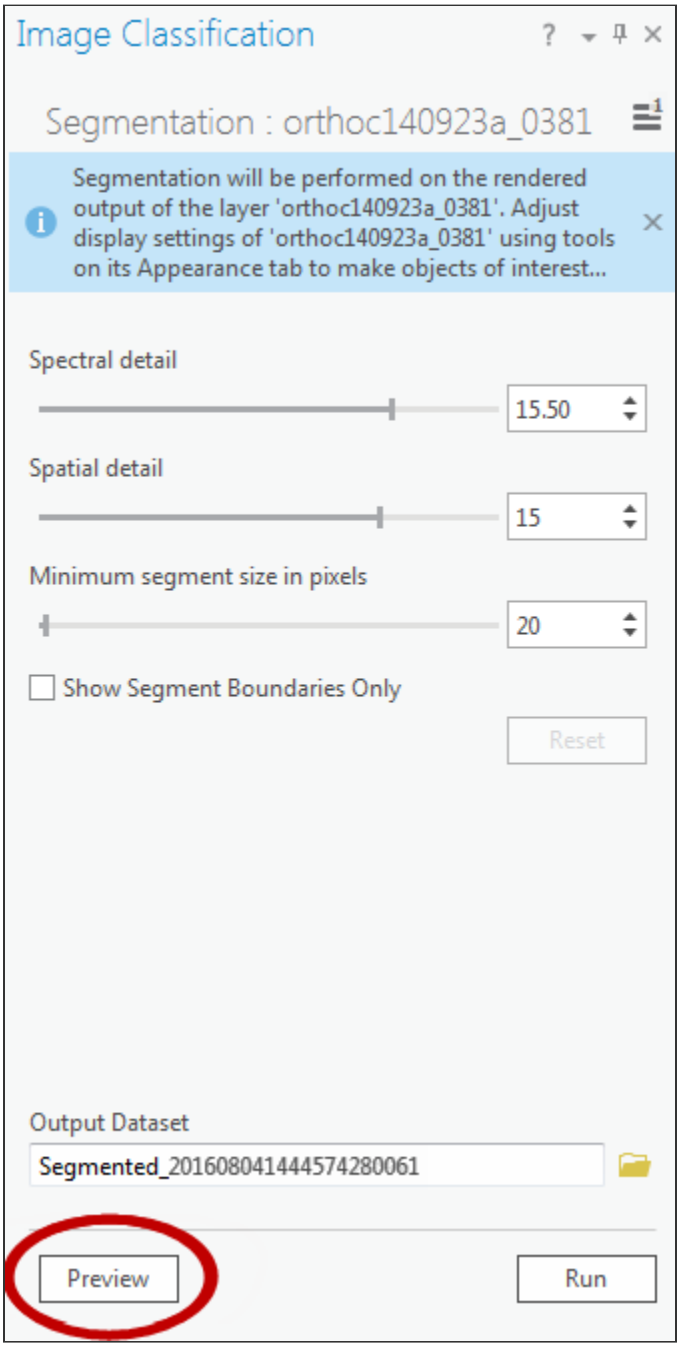

e In the Segmentation pane, accept the default values and click Preview.

A new layer named Preview_Segmented will display in the Contents pane. It should look like the following image.

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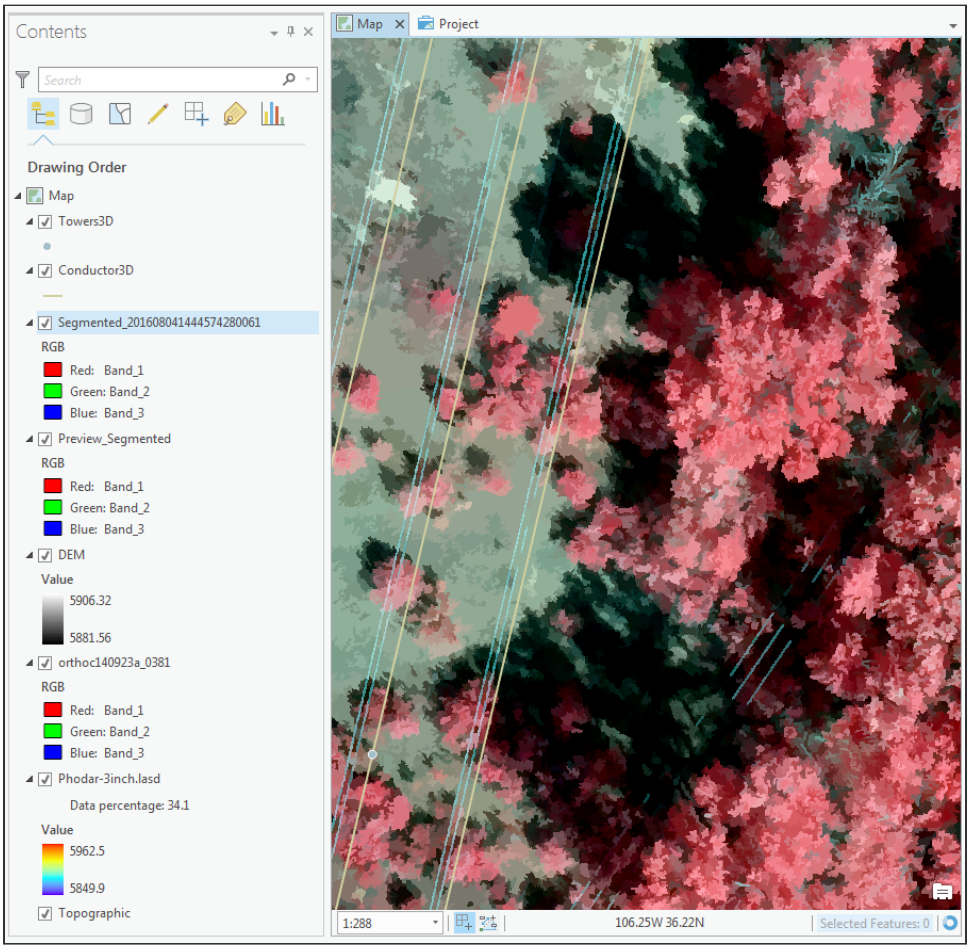
Note: If you're zoomed in to a different area and want to compare your results, right-click the Preview_Segmented image and choose Zoom To Layer, and then right-click again and choose Zoom To Source Resolution.



Depending on your computer, it may take a moment for the segmentation preview layer to process. In the bottom right of the screen, you will see a spinning blue circle that indicates that it is still processing. After it is complete, the segmentation layer will appear.

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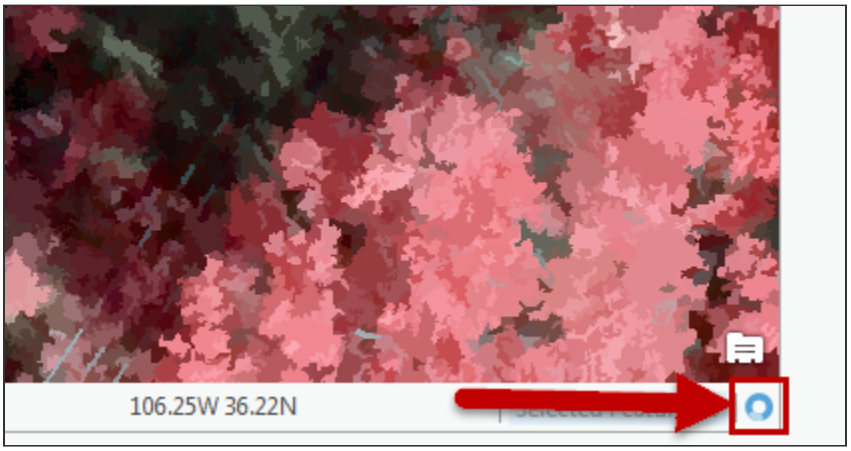

f Press the L key to turn off the segmented layer and see the imagery.

Note: You may have to click the Segmentation pane to activate this feature.

Although the default parameters do a good job of segmenting the larger trees, these settings miss the shrubs.

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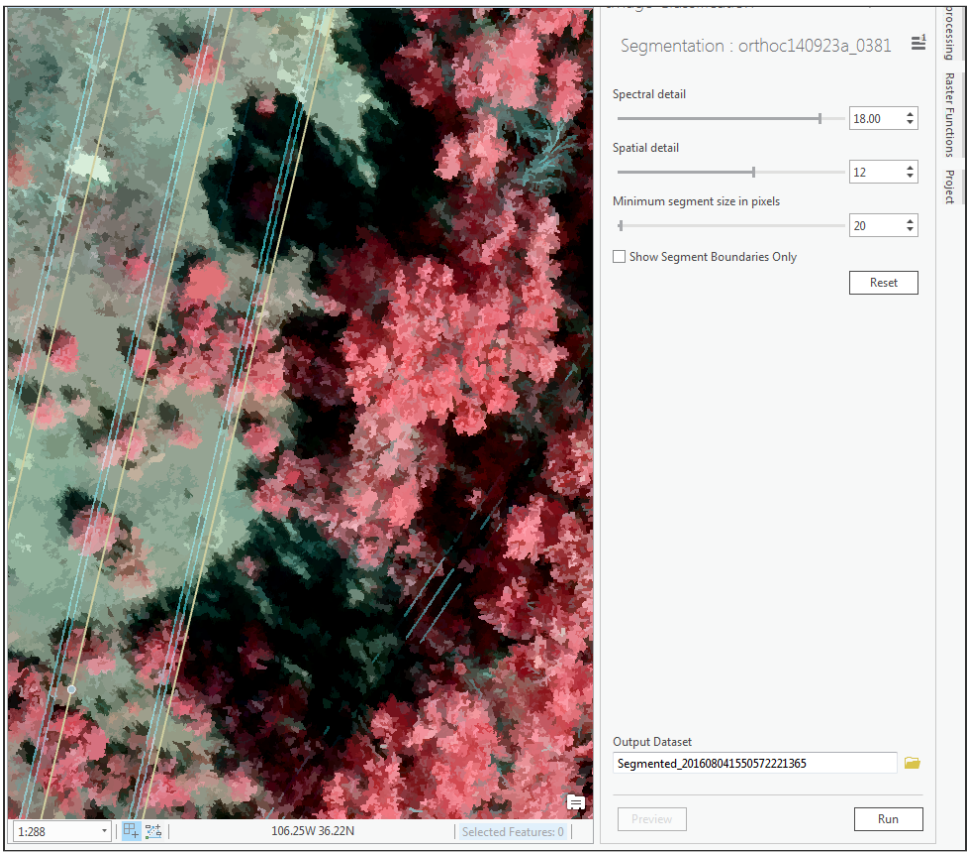
You should adjust the parameters for spectral and spatial detail to help identify the shrubs. You probably want more detail because the bare soil was mixing with sparse vegetation.

g Increase the Spectral Detail value to **18**.

The Preview_Segmented layer updates automatically whenever you change one of the parameters.

There appears to be too much variation in the soil, but decreasing the spatial detail should smooth out some of these segments.

h Lower the Spatial Detail value to **12**.



There is good detail in the vegetation, which is the feature you're interested in. The soil is smooth, which is helpful because it's the background in this image.

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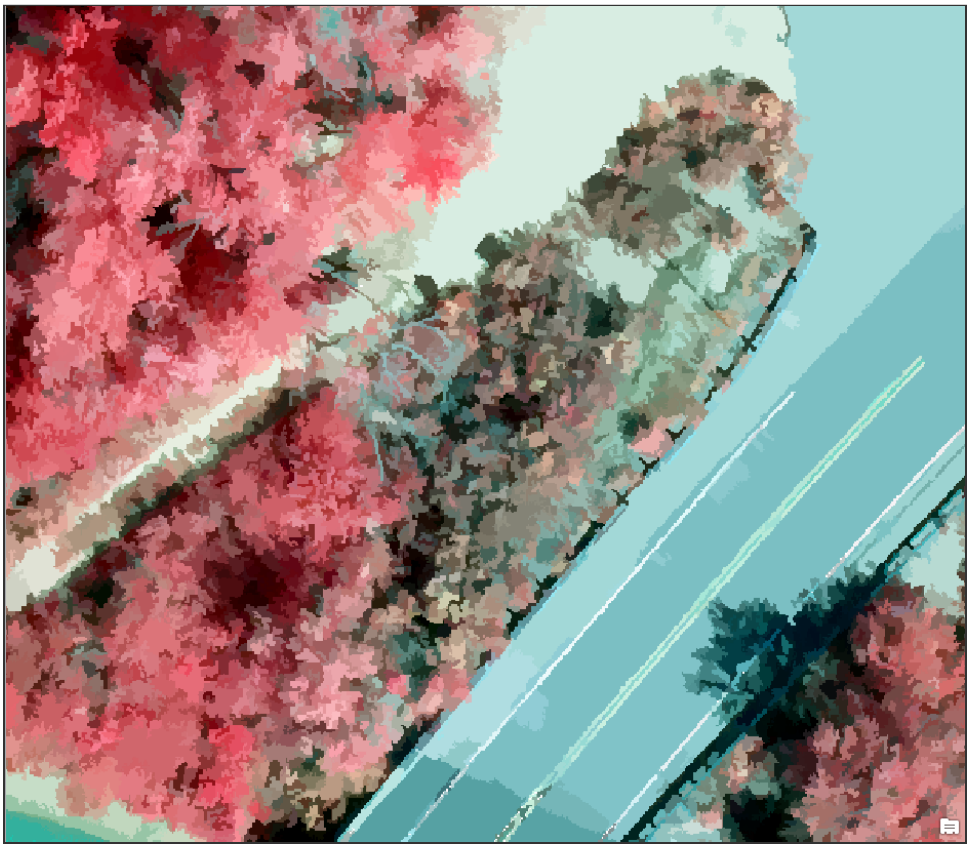
Note: In the remote sensing world, the concept of background is quite important. In short, it's everything that you're not really interested in. In this case, you need to know where vegetation is, so soil is the background. If you were interested in soils, the vegetation would be the background, and you could treat all grass, trees, shrubs, and related growth as one feature.

Next, you perform a spot check in different parts of the image. Here are screenshots of areas by the road with a lot of bare earth and of the forested area beneath the power lines south of the river.



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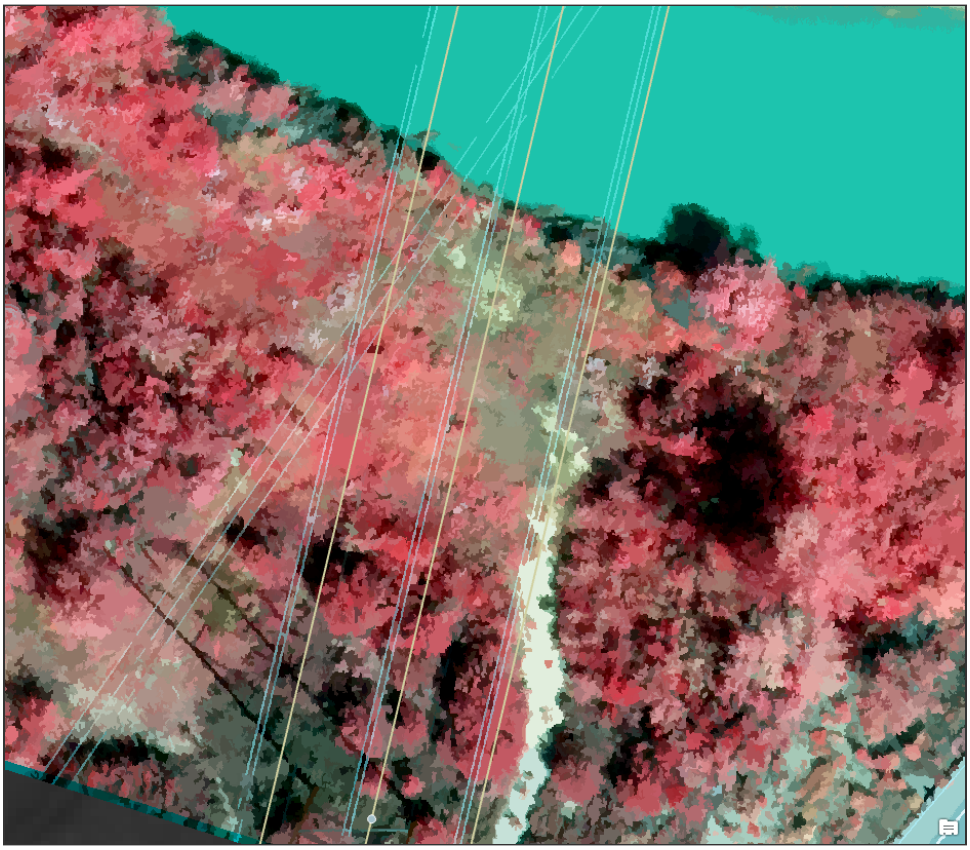
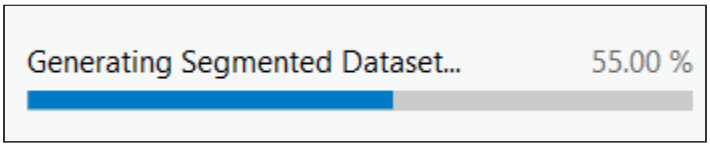


These all look pretty good because the vegetation is well segmented. Next, you can run the tool and save the output.

i On the Segmentation tool, click Run.

This will save the segmented image. The action may take a few minutes to process, so if you want to stretch your legs or go grab a cup of coffee, now is a good time.

You can check the progress at the bottom of the Image Classification pane.



Step 5: Create a vegetation mask using unsupervised classification

After segmenting the image, you need to create a vegetation mask. The goal is to create a new image with two values: pixels with the value "1" representing areas with vegetation, and pixels with the value "0" representing areas that do not have any vegetation (which could be

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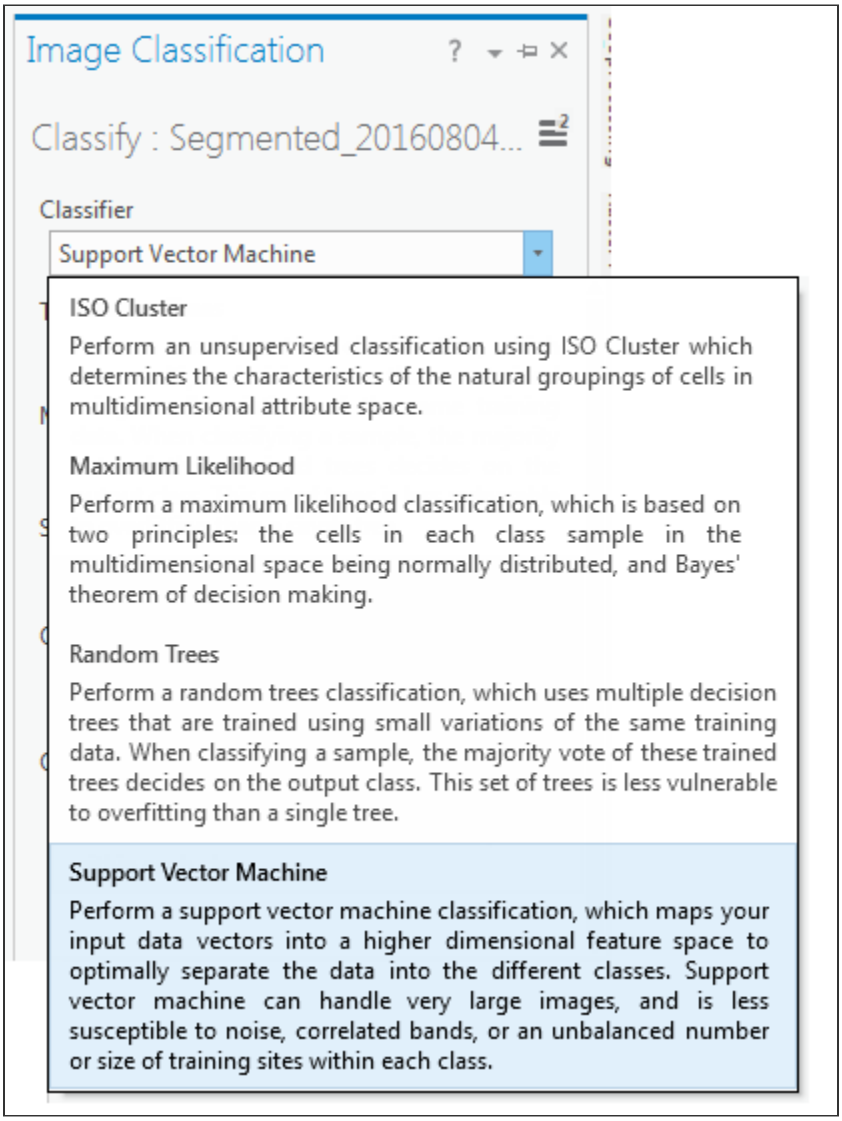
roads, water, or bare earth). You're really only interested in where the vegetation is, so you can think of the other category as everything else.

a From the Classification Tools drop-down list, choose Classify.

You can use four classification algorithms to classify an image. The first one, ISO Cluster, is what's known as an unsupervised classification because you're essentially asking the computer to decide what should get grouped together. You set the maximum number of classes that you want it to group everything into (in this example, there are four classes: vegetation, water, soil, and roads), and then it produces an output where each object is assigned a value (from 1-4 in this example). Then, you must manually assign a name to each class (1 represents water, 2 represents soil, and so on).



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The other three options (Maximum Likelihood, Random Trees, and Support Vector Machine) are all supervised classifiers. When you use these classifiers, you select a few segments that represent each of the features in the image. Then, you tell the computer to go find the rest of them based on the characteristics of the features that you have selected. Either option is fine, and remember, all you care about is identifying the vegetation that is near the power lines. Water, roads, and soil will all get grouped together as "non-vegetation," and misclassified vegetation that is away from the power lines does not affect the electric utility company.

b. In the Contents pane, select the orthoc140923a_0381 layer.

c. In the Classify tool, for Classifier, choose ISO Cluster. (It will be the first item on the list, and you may have to scroll up to see it.)

d. Accept all of the defaults.

e. For Segmented Image, choose the output of the Segmentation tool that was created when you clicked Run.

Note: Make sure it's not the preview layer.

When you select the segmented layer, a list of attributes will appear.

f. In the Segment Attributes section, check the Standard Deviation and Count Of Pixels check boxes.

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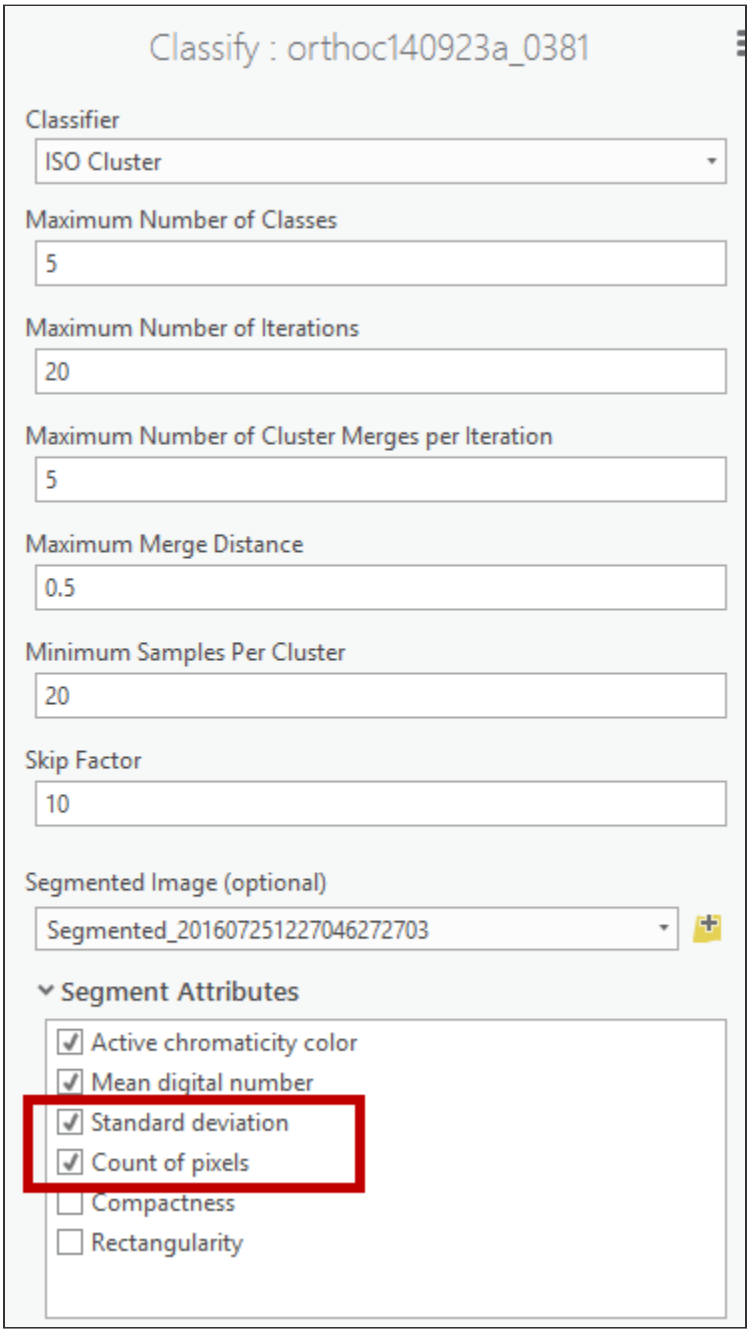

g Click Run.

Your output may have a different color scheme because the colors are randomly assigned. The screenshots provided for the remaining steps reflect the colors that the author received.

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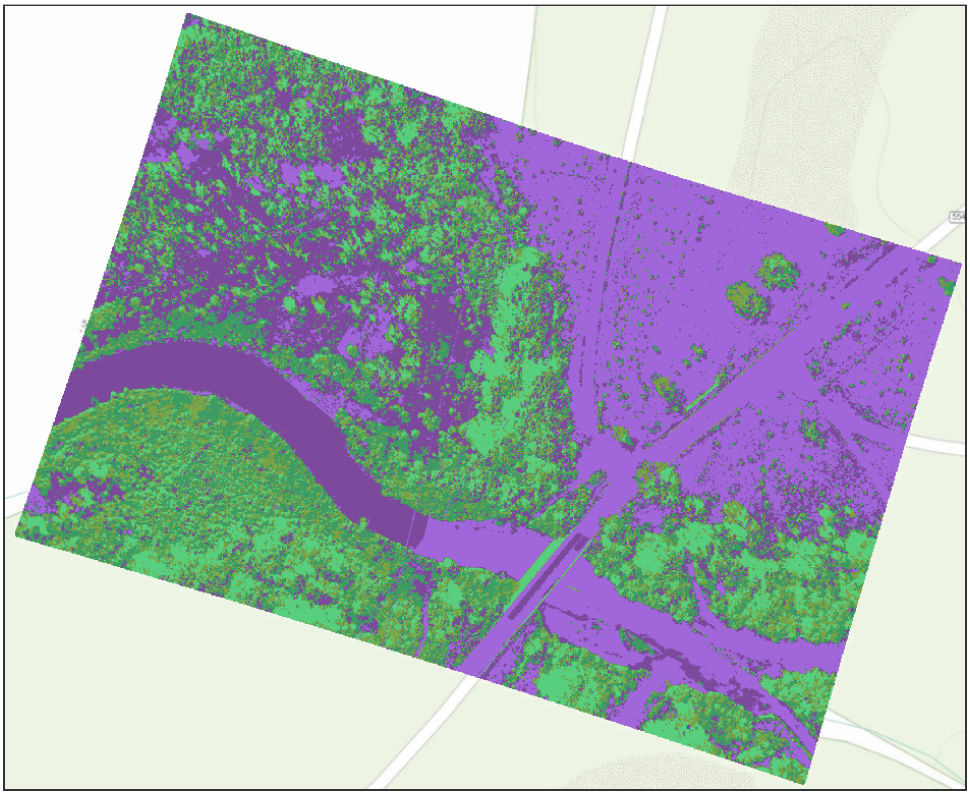

The next task is to assign a name to both classes.

h. With the Classified layer selected, on the ribbon, click the Imagery tab, and then click Classification Tools.

i. From the Classification Tools drop-down list, click Assign Classes.

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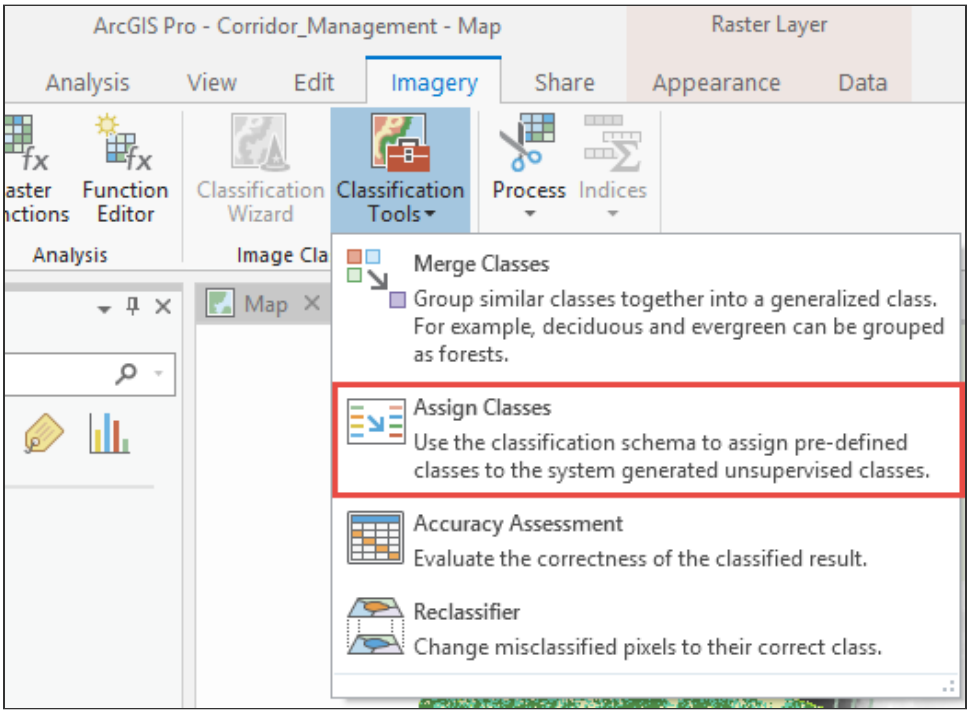

You will see a default schema that is based on the National Land Cover Dataset, which is a schema that is used primarily in the United States.

j Near the top of the pane, right-click the Barren class and choose Edit Properties.

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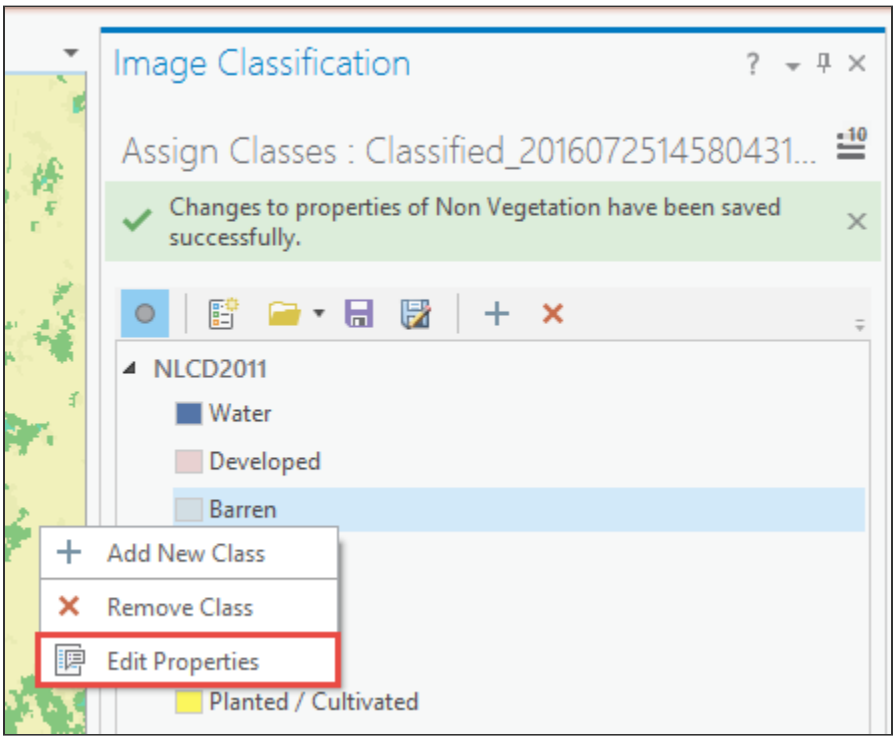

k In the Edit Class Properties dialog panel, change the name to **Non Vegetation**, and click OK.

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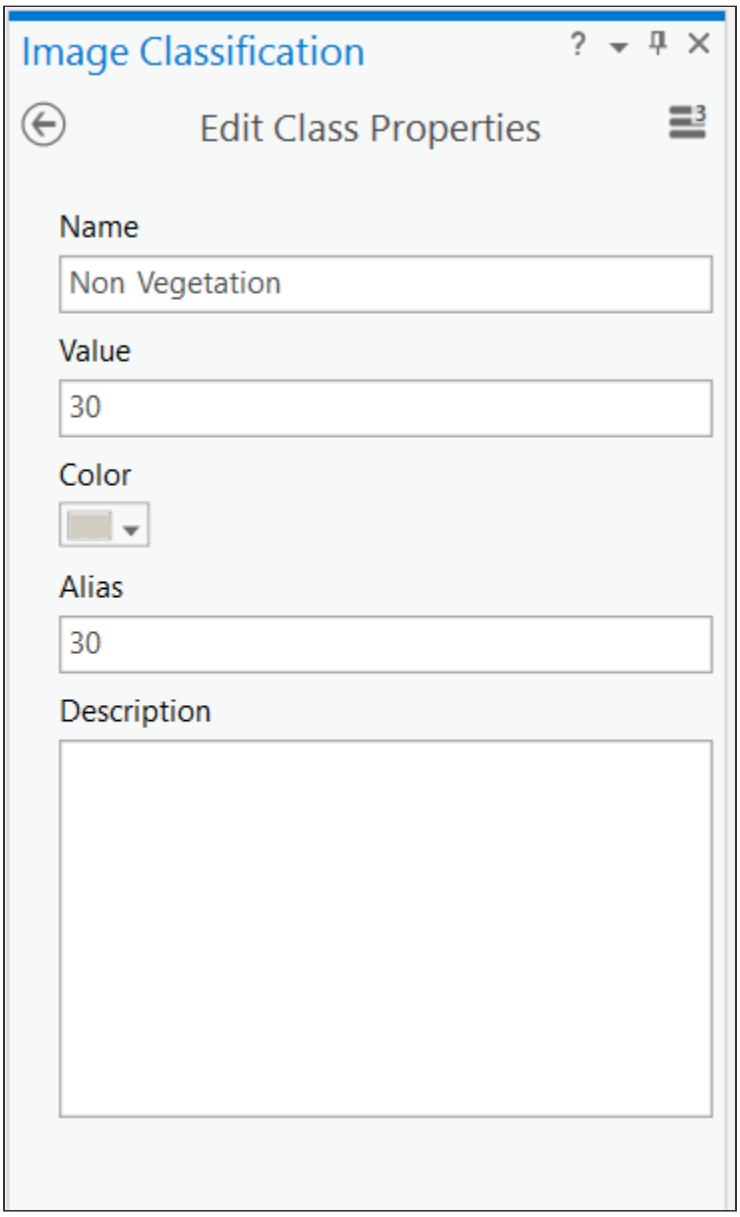

l With the Non Vegetation class selected, click the Assign tool, and then click a part of the image that you know is not vegetation, like the road or the river.

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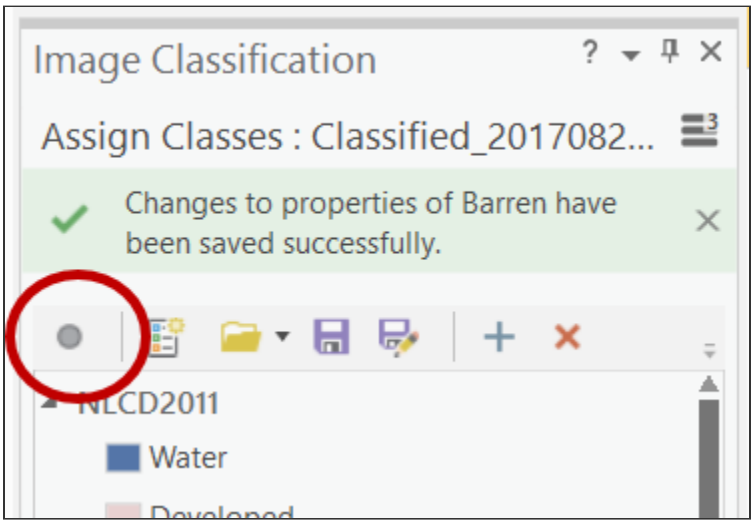
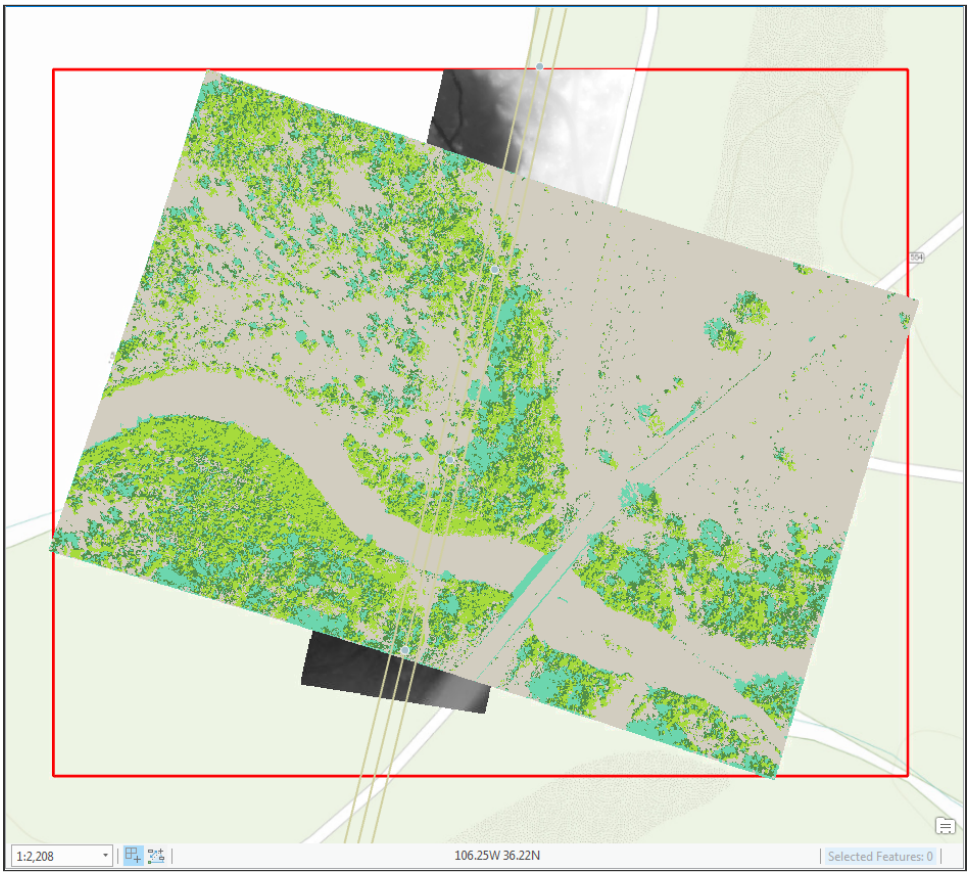


Because ISO Cluster uses an algorithm that depends on random values, you will have different values for the two classes. In my example, classes 2 and 3 were assigned to Non Vegetation. Yours may have different values for the Non Vegetation classes. Regardless of how it gets remapped, your image will look similar to the one below.



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You will now repeat this process for the Forest class but will mark it as Vegetation.

m. Right-click the Forest class and choose Edit Properties.

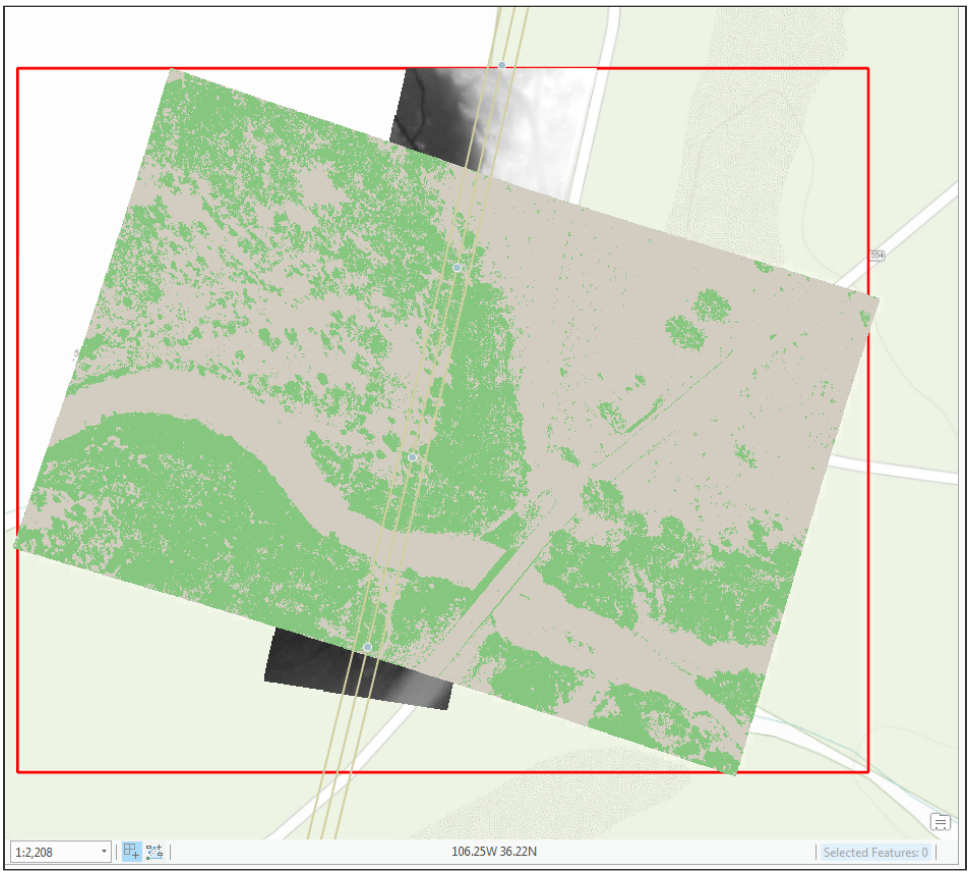
n. In the Edit New Class dialog panel, change the name to **Vegetation**, and click OK.

o. With the Vegetation class selected, click the Assign tool, and then click all of the areas that you know are vegetation in the image.

After this is complete, classes 0, 1, and 4 should be assigned as Vegetation.

Your image should look like the one below.

Note: If you click the wrong part of the image, select the class that it should be from the top part of the pane and then click the appropriate part of the map. This will overwrite the erroneous selection. You can do this as many times as necessary.



Hint: When assigning classes, you will notice that Class 0 is shadow, which sometimes covers soil and sometimes covers other vegetation. Mark this as Vegetation. You will use the Phodar data to account for this discrepancy because it will measure the height.

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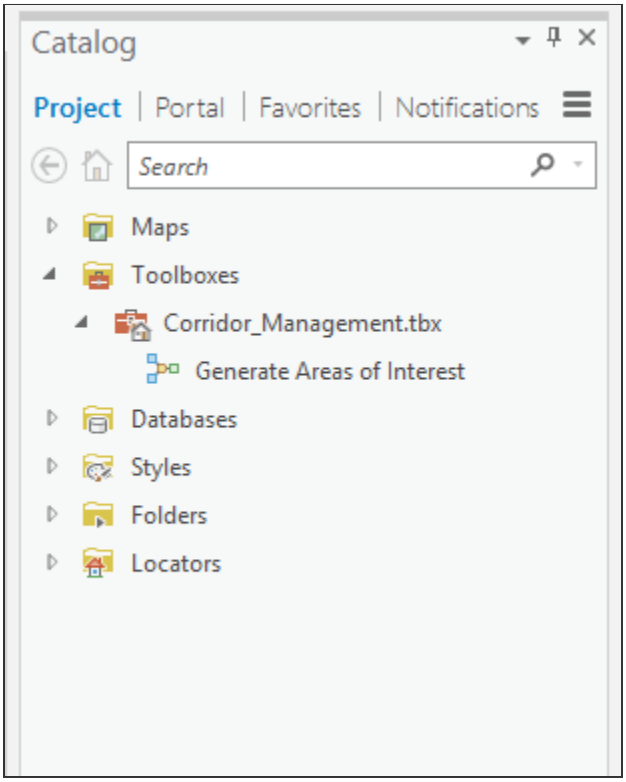
p When you are finished assigning classes, click Run.

The result will be added to the Contents pane and will start with "Merge_" followed by a string of numbers.

Step 6: Use 3D point cloud data to identify the tree canopy

After classifying the image, the next step is to use the 3D point cloud data to identify where the tree canopy is encroaching on the power lines. You will use the vegetation mask and the point cloud to do this.

a In the Catalog pane, expand Toolboxes, and then open the Generate Areas Of Interest tool.



The area of interest polygons are created using the vegetation mask to select points in the point cloud that represent vegetation height and grouping these points into polygons.

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b. In the Generate Areas Of Interest pane, from the Parameters tab, use the following settings for the vegetation mask:

- For Input LAS Dataset, choose Phodar3inch_LasDataset.lasd.
- For Input Classified Segmented Vegetation Image, choose the output of the previous steps (the layer that starts with "Merge_" followed by a string of numbers).
- For Input DEM, choose the DEM layer.
- Accept all of the other defaults.

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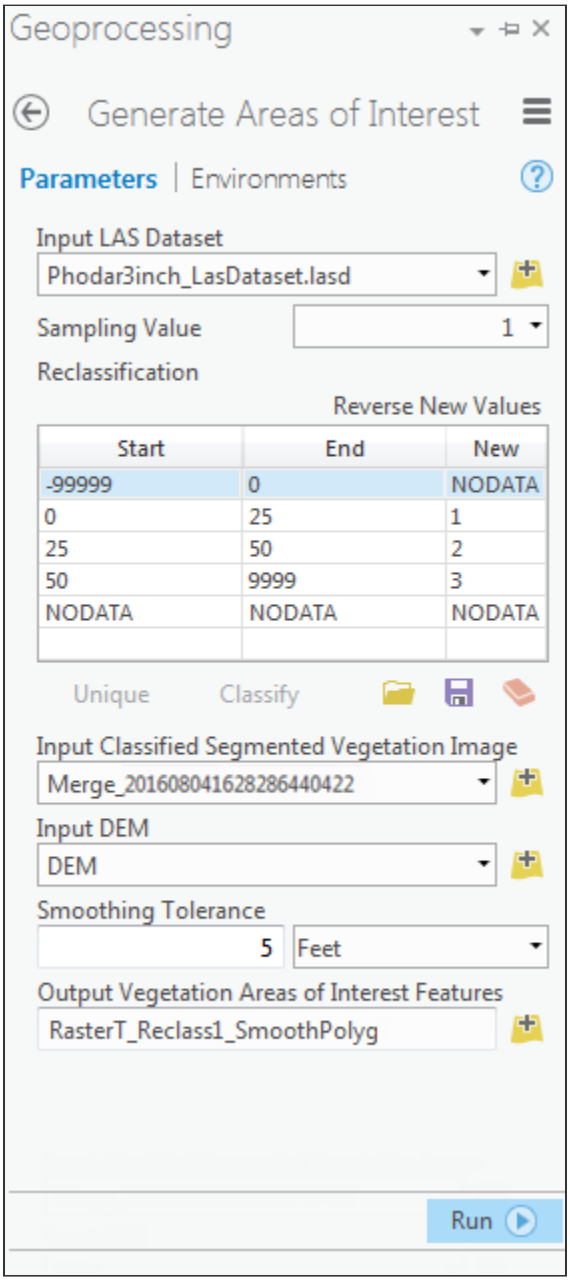

c. Click Run.

The polygons that are created from this step highlight all of the vegetation that is close to the power lines. They are delineated based on their heights. The red polygons represent canopies that are both tall and too close to the power lines and need to be trimmed back or removed.

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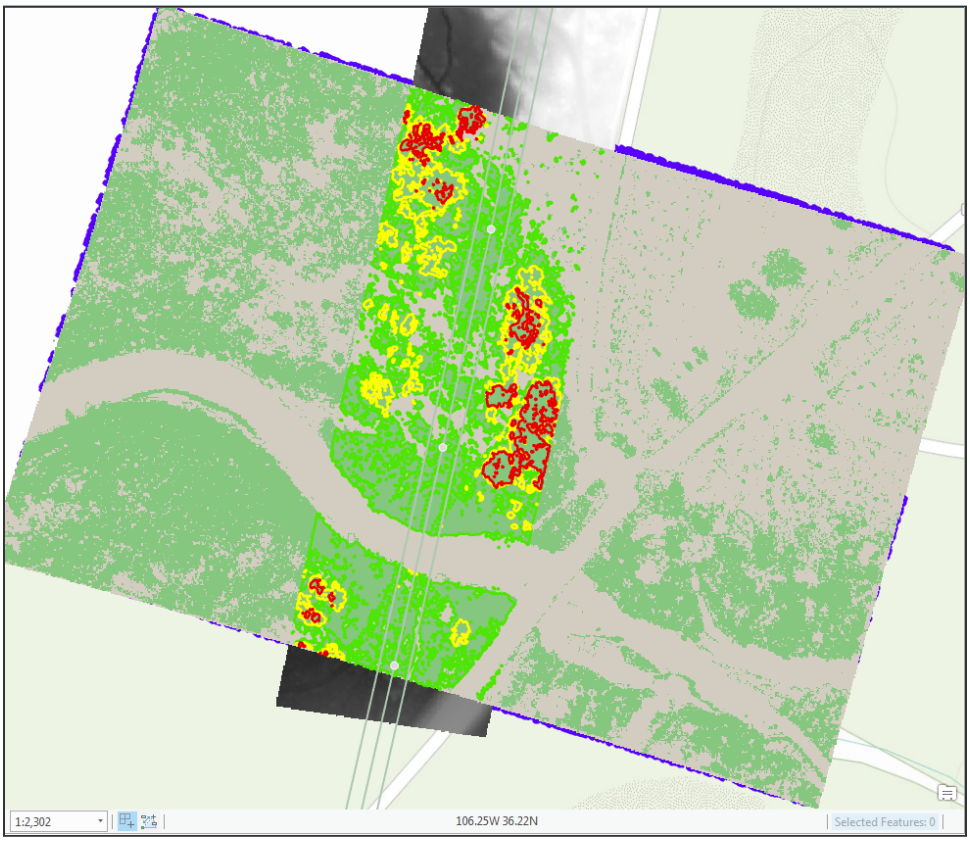

Conclusion

In this exercise, you learned how you can use imagery to identify tree canopies that are in close proximity to power lines and pose a threat to the utility company's ability to ensure that electricity is always flowing.

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