

Exercise 1: Use imagery to locate areas of interest

How can I print an exercise to PDF format?

Note: ArcGIS Online and the Landsat Explorer app are dynamic apps, so what you see may vary slightly from the graphics included in this exercise.

Software Requirements

- An updated internet browser

Introduction

Imagery can be used in various ways in ArcGIS—from providing context to any location-based study to being the focus of the study when making new discoveries or quantifying aspects of the study area. When using imagery, or remote sensing data, one of the first steps to perform is to examine the data itself. The potential to discover and identify features in imagery is directly related to the characteristics found in the imagery dataset.

There are many types of imagery, and each type has unique characteristics that can be used to find desired features. The characteristics of each imagery dataset are related to the type of sensor used to collect the imagery. Depending on the sensor, the type and amount of characteristics can be very different. These characteristics can be found in the dataset's metadata and often include details such as the collection date, the area, and spatial reference.

Understanding technical aspects of the imagery will improve your ability to find desired features in your study area. Remote sensing data collects information about features and presents this information as values in an image, which are stored as raster bands. The measure of a single characteristic is recorded as an element in one of these raster bands. Individual imagery datasets can contain many raster bands. You can combine and display raster bands as band combinations or band composites, depending on your visualization needs.

To learn more about how raster bands can be used to discover a desired feature, you will use the Landsat imagery layer available from ArcGIS Living Atlas of the World. Imagery collected by Landsat satellites is used to observe and monitor the earth.

In this exercise, you will use the ArcGIS Landsat Explorer app to view the Landsat image layers and explore various study areas. Additionally, you will learn about possible techniques to discover desired features by manipulating different raster bands within the layer.

Scenario

Imagine that you are a GIS analyst for a local government, and you have been tasked with assessing the potential impact of revisions to the water policy. To determine which businesses will be most affected by any water policy changes, you will locate the areas that have the greatest amount of vegetation and will require the most irrigation. Through functionality in the Landsat Explorer app, you will explore the area with satellite-based image services and locate the areas with the highest vegetation index values.

Note: The exercises in this course include View Result links. Click these links to confirm that your results match what is expected.

Estimated completion time in minutes: 40 minutes

[Expand all steps](#)

[Collapse all steps](#)

- Step 1: Access your MOOC credentials

First, you will visit the MOOC home page to locate your course account username and password.

a On the MOOC home page, next to Dashboard, click Lessons.

b Under Lessons, locate ArcGIS Account Information.

This information is your course ArcGIS account username and password. You will use these credentials to download ArcGIS Pro and complete all the MOOC exercises. The username for this account ends with _iact (for example, jdoe_iact). You may want to write down the username and password for quick reference. You can also return to the Lessons tab anytime to locate your credentials.

Note: If you registered within the past few hours, your account may not be ready. Refresh the page in an hour or so to determine whether your account is available.

- c Open a web browser in private or incognito mode.

Note: To learn how to enable private browsing, see the article How to Enable Private Browsing on Any Web Browser (<https://links.esri.com/HowToBrowse> | <https://www.howtogeek.com/269265/how-to-enable-private-browsing-on-any-web-browser>).

- d In the address bar, type **www.arcgis.com** and press Enter.

*Step 1d***: Access your MOOC credentials.*

- e Click Sign In.
- f Under ArcGIS Login, enter your course ArcGIS username and password.

*Step 1f***: Access your MOOC credentials.*

- g Click Sign In.
- The first time that you sign in, you may be asked to change your password and set a security question.
- h If necessary, follow the on-screen instructions to change your password.
- i Follow the on-screen instructions to set your security question.

*Step 1i***: Access your MOOC credentials.*

Note: An automated email will be sent to the email address associated with the account, telling you that your account was recently modified. No action is required.

After you set your security question, you will see the home page of the MOOC organization. You now have your MOOC account information and access to the MOOC organization.

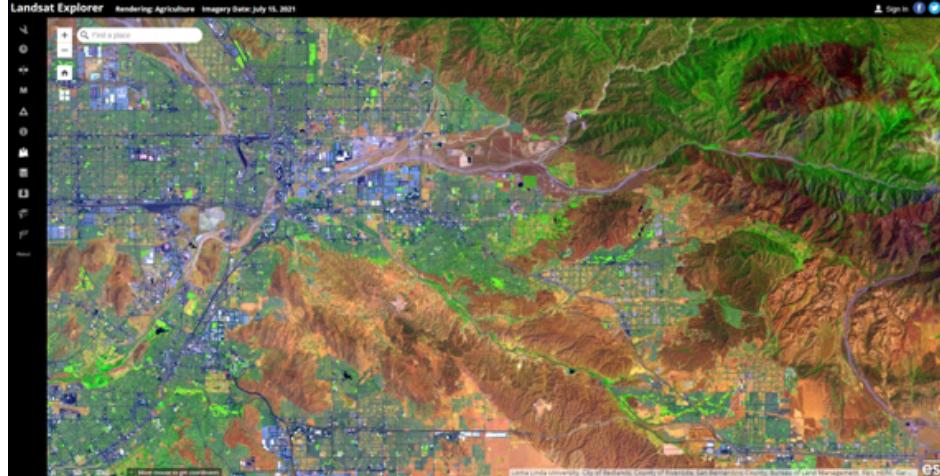
- j If you would like, bookmark the MOOC organization home page.
- k Keep your web browser open.

- Step 2: Discover how spectral information is reported

In this step, you will explore the Landsat Explorer web app, see how spectral information is expressed in the raster bands, and explore rendering possibilities to begin your research.

The web app can be used to access the Landsat imagery layers that are available in ArcGIS Online. The web app is capable of displaying the Landsat data in various ways that you will begin to explore in this exercise.

- a In a web browser, go to the Landsat Explorer web app.



Step 2a***: Discover how spectral information is reported.

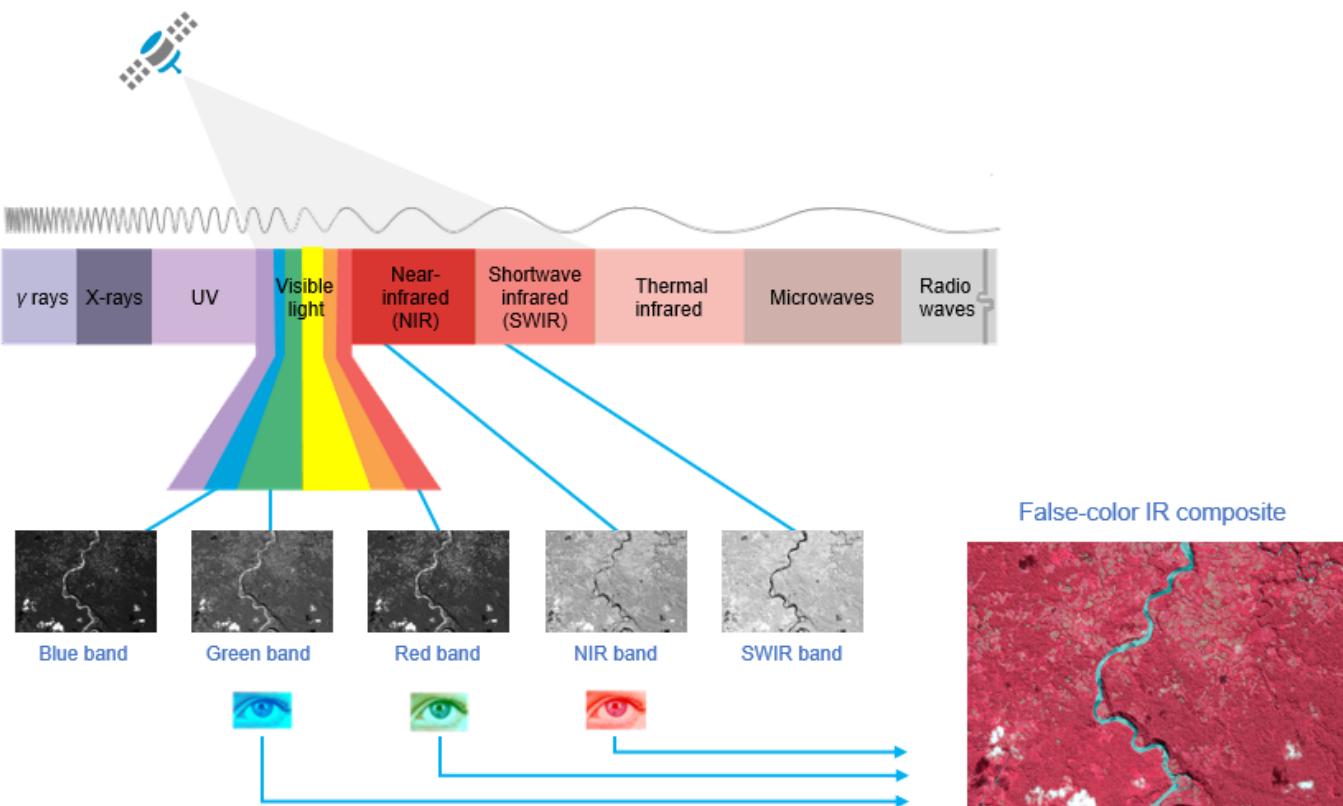
The Landsat program was started in 1972 through a joint program of NASA and the U.S. Geological Survey to launch a series of earth observation satellites and provide continuously acquired images of the earth's land surface. The purpose of this project is to help land managers and policymakers make informed decisions about natural resources and the environment.

For more information about the Landsat program, visit the USGS website on Landsat Missions (<https://links.esri.com/LandsatMissions> | <https://usgs.gov/core-science-systems/nli/landsat>).

There have been multiple Landsat satellites in the program since 1972. With each new satellite, and as technology continues to improve, more advanced sensors capable of collecting information are included to enhance our understanding of the earth's changing environment. The information collected by the sensor is reported as spectral bands of data based on its location and a specified width on the electromagnetic spectrum. The newest satellite, Landsat 9, launched in September 2021 and carries improved versions of the sensors on Landsat 8.

The Landsat 9 sensor collects 11 spectral bands. For more information about the specific wavelengths collected, visit the USGS website for the Landsat 9 sensor (<https://links.esri.com/USGSLandsat9> | <https://www.usgs.gov/landsat-missions/landsat-9>).

The Landsat sensor's spectral bands are reported as raster bands when viewed in ArcGIS apps. There is a raster band for each spectral band collected by the satellite.



The spectral information is reported as raster bands.

Raster bands can be combined in different ways. This process is known as rendering. With rendering, three individual bands are combined to create a visualization where certain landscape features are more visible.

The rendering options for each Landsat image depend on the metadata, which provides information on which of the 11 total bands are present in the product.

Esri provides a series of Landsat image layers as dynamic imagery layers. Preconfigured visualizations from the Landsat raster bands are available with the layers. These custom visualizations are called renderers.

Landsat Explorer lists the renderer being used for visualization at the top of the app, near the name and the date of the centermost Landsat image.

? Which renderer is currently being used in the display?

- Answer

The Agriculture renderer is indicated.

- b** In the Landsat Explorer web app, to see more information about the renderer, from the left toolbar, click the Renderer button .
- c** In the Choose Rendering window, click the Information button to see the band combination and the features or studies for which it is recommended.

? What is the band combination for the renderer?

- Answer

The band combination is 6,5,2.

Multispectral bands for Landsat 8 and 9	
Band	Description
1	Coastal Aerosol
2	Blue
3	Green
4	Red
5	Near Infrared
6	Shortwave Infrared 1
7	Shortwave Infrared 2
8	Panchromatic
9	Cirrus
10	Thermal Infrared Sensor 1
11	Thermal Infrared Sensor 2

? Based on the band information from the preceding table on Landsat 8 and 9 bands, what are the names of the bands used in this renderer?

- Answer

Shortwave Infrared 1, Near Infrared, and Blue are the names of the bands.

This combination of bands uses two spectral bands that are not visible to the human eye to create a custom visualization to see vegetation easier.

? Which types of features is the renderer recommended for?

- Answer

It is recommended for agricultural studies where the vigorous vegetation appears a darker green.

This renderer appears to be a good choice based on the study parameters. The vegetation areas are clearly visible in the map. However, because you are just beginning the research, you will consider other choices before deciding on the renderer to use.

The Landsat Explorer app opens with Redlands, California, in view. The mountains to the east and the developed areas are visible in this spatial extent.

- d In the Choose Rendering window, click the down arrow and choose Natural Color.



*Step 2d***: Discover how spectral information is reported.*

The Natural Color renderer displays the Landsat as you would see the area, as if viewing the area overhead from a plane. It uses the Red, Green, and Blue bands for display.

Each Landsat image has a reported cloud cover value, which represents the percentage of an area covered by clouds. A low value is ideal.

Note: This live service is updated daily. Depending on the imagery for a particular day or the size of your web browser, the display may show greater cloud cover than desired.

- e If the display is not satisfactory, consider resizing the web browser display.

- Hint

If resizing the web browser does not work, on the toolbar, click the Time Selector button and choose the option to reduce the cloud cover. Keep in mind that if you use the time selector option, the view of the study area may not be the most current.

- f Change the renderer to Color Infrared.

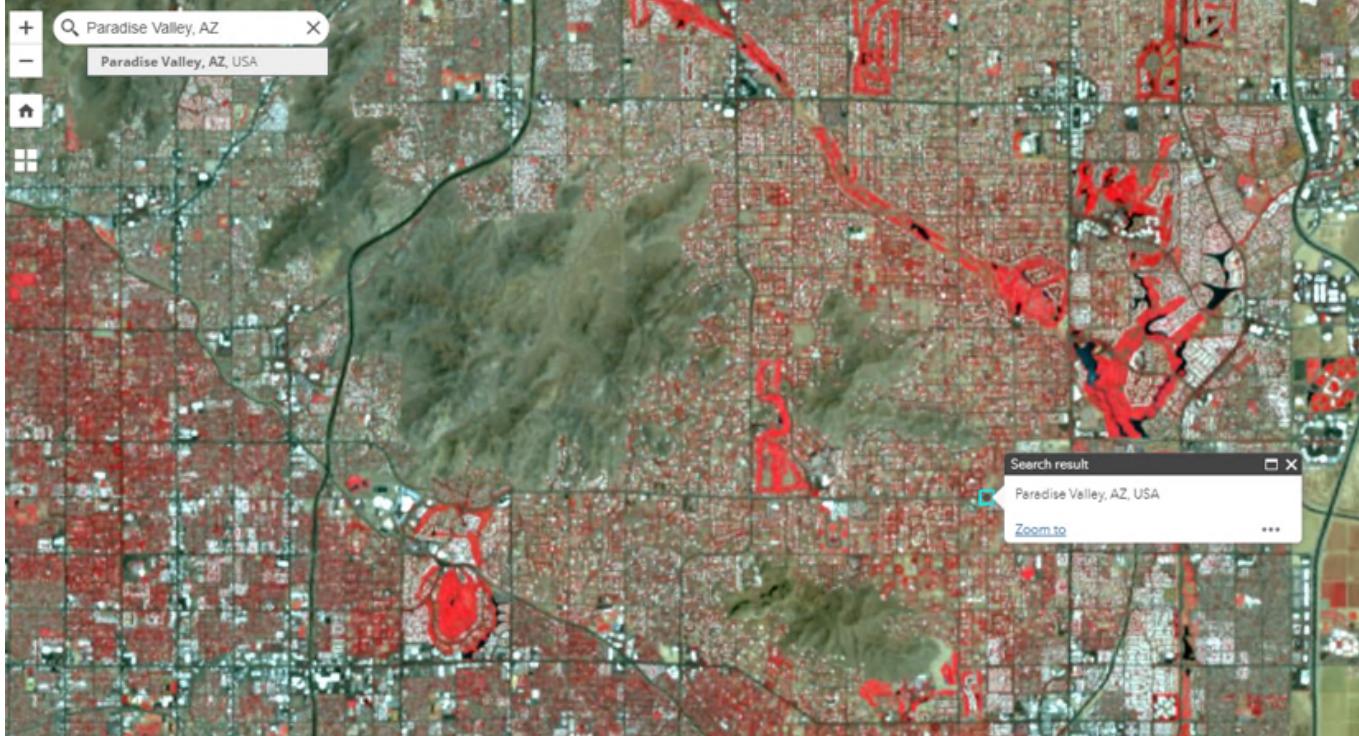
This renderer will display healthy vegetation in shades of red using the Near Infrared band.

Now that you have worked with a few of the rendering options in the Landsat Explorer app, you are ready to start your research.

- Step 3: Visualize the study area

In this step, you will begin the process of choosing the best visualization to find vegetation around Paradise Valley, Arizona, with the Landsat Explorer app.

- a If necessary, close the Choose Rendering window.
- b In the Find A Place field, type **Paradise Valley, AZ** and press Enter.



Step 3b***: Visualize the study area.

The search results will list any variations of the location name, and a cyan outline will appear in the center of the map to indicate the location.

Without panning the view within the map, are there any visible features that stand out?

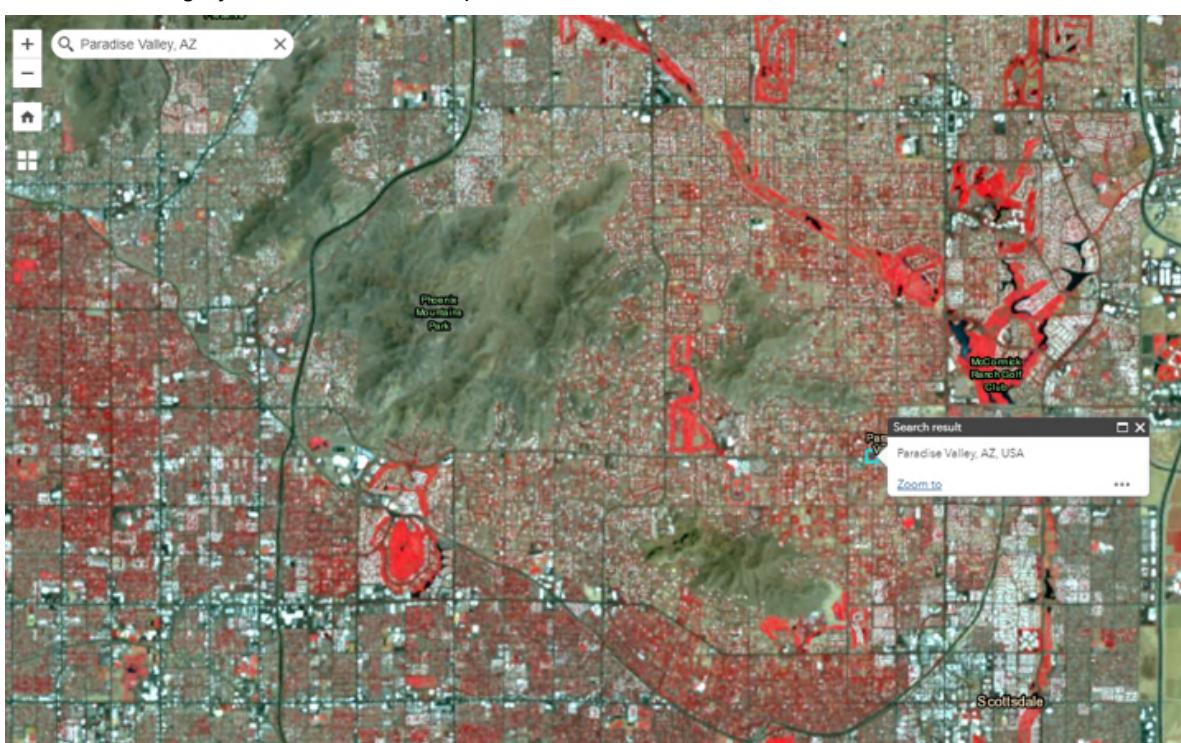
- Answer

Some darker red areas appear to be vegetation.

Because you left the renderer set to Color Infrared, this rendering is how the study area is visualized initially. The other rendering options are available just as before, and you should consider them as you look for the combination that will allow you to locate the vegetation areas.

In addition to the rendering options, you can add layers in the Landsat Explorer app, just like you can in other ArcGIS apps.

- c To see the available basemaps, in the upper-left corner of the map, click the Basemap Gallery button .
- d Choose the Imagery With Labels basemap.



[Step 3d***: Visualize the study area.](#)

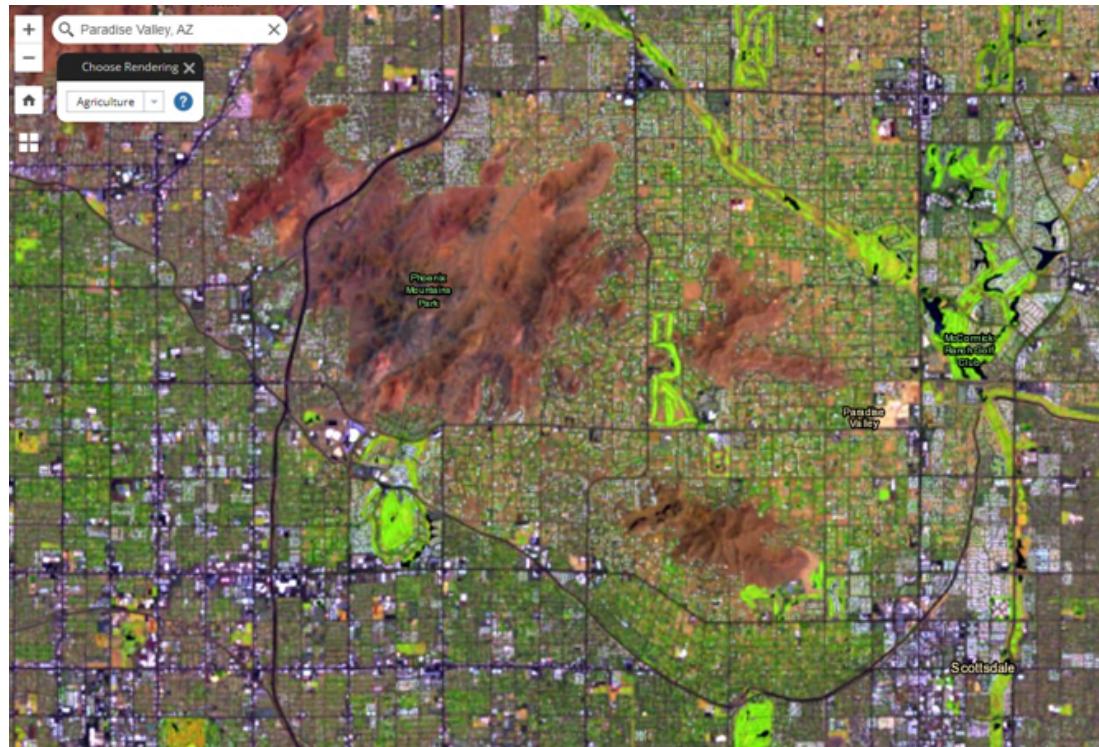
While the basemap is only visible under the Landsat imagery layer, you can use one of the layers to add some contextual information. For some studies, the imagery layer provides context—in this case, the place names will provide enough context so that you are sure that you are in the desired location.

- e If necessary, drag the map (click and hold the click) to reposition the area so that you can see the Phoenix Mountains Park in the upper left of the visible area and Scottsdale in the lower right.
- f Survey the study area with the labels present.

 Focusing on the vegetation (darker red), what are some common features of the areas in which they are located?

- Answer
They are parks and golf courses.

- g Change the renderer back to the Agriculture renderer, and then close the Search Result pop-up in the map.



[Step 3g***: Visualize the study area.](#)

- Hint

Click the Renderer button  and choose Agriculture.

The vegetation areas are now a bright green and are clearly visible in this renderer, too.

Now that you have found two band combinations that reveal the vegetation in the Landsat Explorer app, you have a good start to your research into the areas that will be most affected by any change to the water policy.

 Using your knowledge about the two raster band combinations, which raster band or bands are used in both renderers?

- Answer
The Near Infrared band is used in both renderers.

Note: Be sure to check the information about each renderer in the Choose Rendering window or the item page for more information.

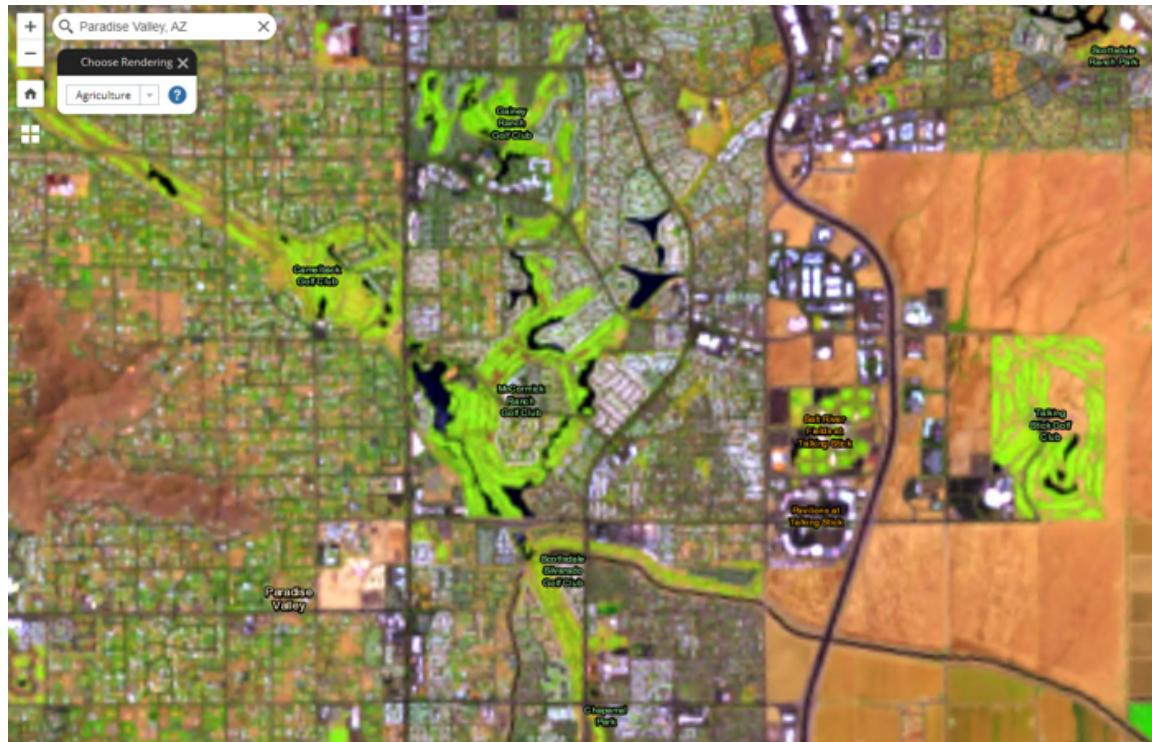
Now that you have tried different rendering options in Landsat Explorer, you are ready to begin creating the report for your manager.

- Step 4: Add a study area layer to the map

You have just received information that the requirements for your study have changed and that you will need to create a layer that determines the size of the vegetation area that could be affected by the water policy.

In this step, you will create a feature layer that allows you to calculate the coverage of vegetation within the study area.

- a In the map, zoom in closer to the McCormick Ranch Golf Club, slightly northeast of your Paradise Valley location.



*Step 4a***: Add a study area layer to the map.*

Note: To zoom in, you can use your mouse wheel or in the upper-left corner of the map, click the Zoom In button .

This area is the general area where you will be researching vegetation coverage. However, your management has now identified a more specific area for the initial study. The layer for the more specific area is available in ArcGIS Online and can be added to the Landsat Explorer app.

- b In the top-right corner of the app, click Sign In, and then type your MOOC credentials and click OK.
- c On the toolbar, click the Add Data From ArcGIS Online button .

You will see a window with a list of available layers. These layers can be added to the app from your organization in ArcGIS Online and are available to add context and enhance analysis. You will add the study area layer to focus your analysis on a particular area.

- d Click the My Organization down arrow and choose ArcGIS Online, as shown in the following graphic.

Search URL File

My Organization ▾ Search...

My Content My Organization Multispectral

ArcGIS Online T.DataStore1

ADD DETAILS

test for date field_fieldworker Feature Service by john.geoapps1

ADD DETAILS

PMC_2017_1502627872911 Feature Service by adenastudent.geoapps1

ADD DETAILS

« « 1 » 3 Items LAYERS

- e In the Search field, type **potential area for water policy owner:esritrainingsvc** and press Enter.

Note: If you do not see the layer in the search results, click Within Map, as indicated in the following graphic, to turn off the option as you may be zoomed in too much.

Add Data from ArcGIS Online X

Search URL File

ArcGIS Online ▾ potential area for water

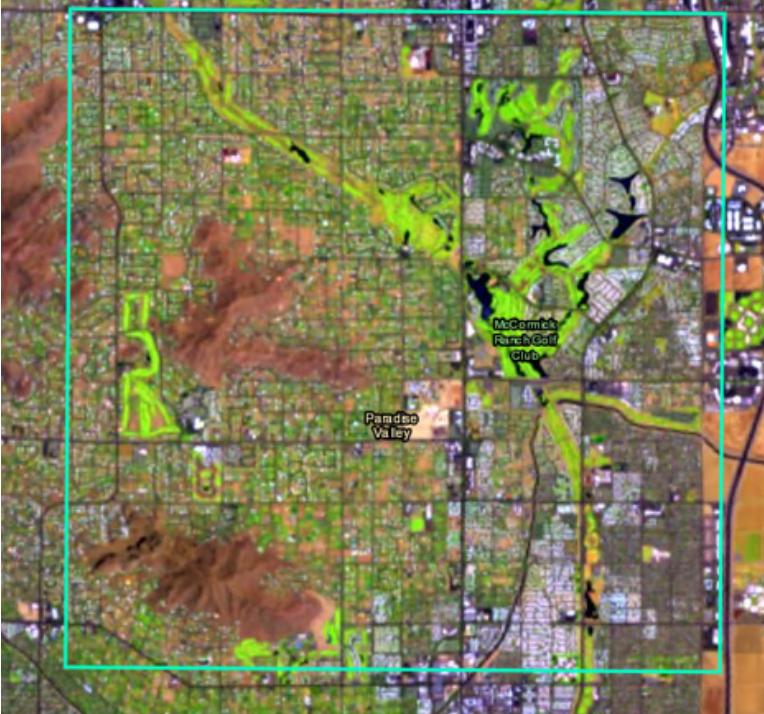
Within map... Type ▾ Relevance ▾

Potential Area for Water Policy Feature Service by EsriTrainingSvc

ADD DETAILS

- f In the bottom-right corner of the result, click Add to add the layer to the map, and then close the Add Data From ArcGIS Online window.

- g If necessary, zoom out so that your map view is similar to the following graphic.



The study area should display as a polygon. The areas of high vegetation are visible on the map, but you will continue your research because you have been asked to measure only the coverage within the study area.

- Step 5: Create a vegetation index

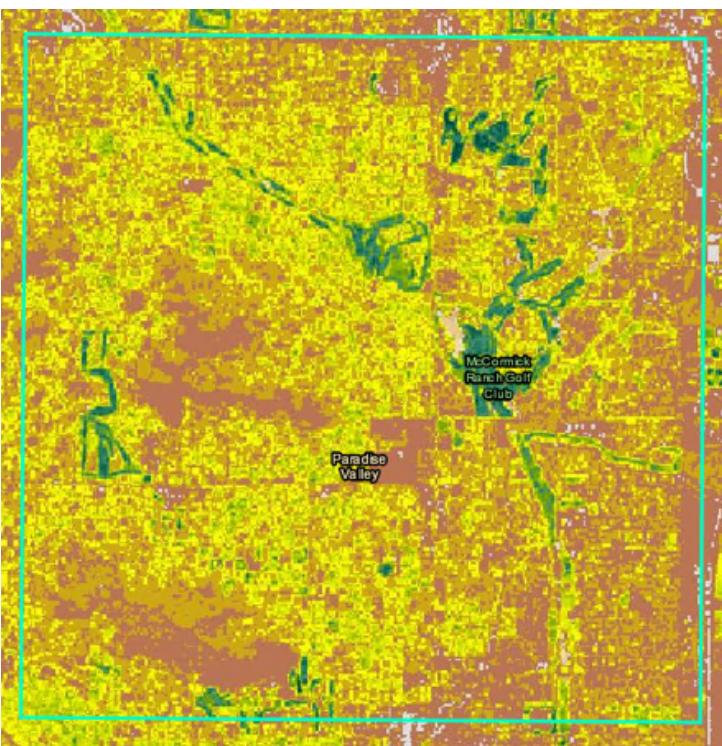
The Landsat Explorer app can display the bands in the Landsat imagery layer in different ways. Some of those are band combinations where the different bands are reordered in the display, but another way is by using band arithmetic. Band arithmetic is where the values in the raster bands are added, multiplied, or divided to create a new visualization.

- a Update the renderer to Vegetation Index.

- Hint

Click the Renderer button and choose Vegetation Index.

Note: If you encounter problems displaying the Vegetation Index correctly, on the toolbar, click the Time Selector button , and then click the Refresh button to update the imagery.



*Step 5a***: Create a vegetation index.*

The Vegetation Index is based on the Normalized Difference Vegetation Index (NDVI) and is used to measure and monitor vegetation health. It uses the Near Infrared and Red raster bands and is calculated with the following formula:

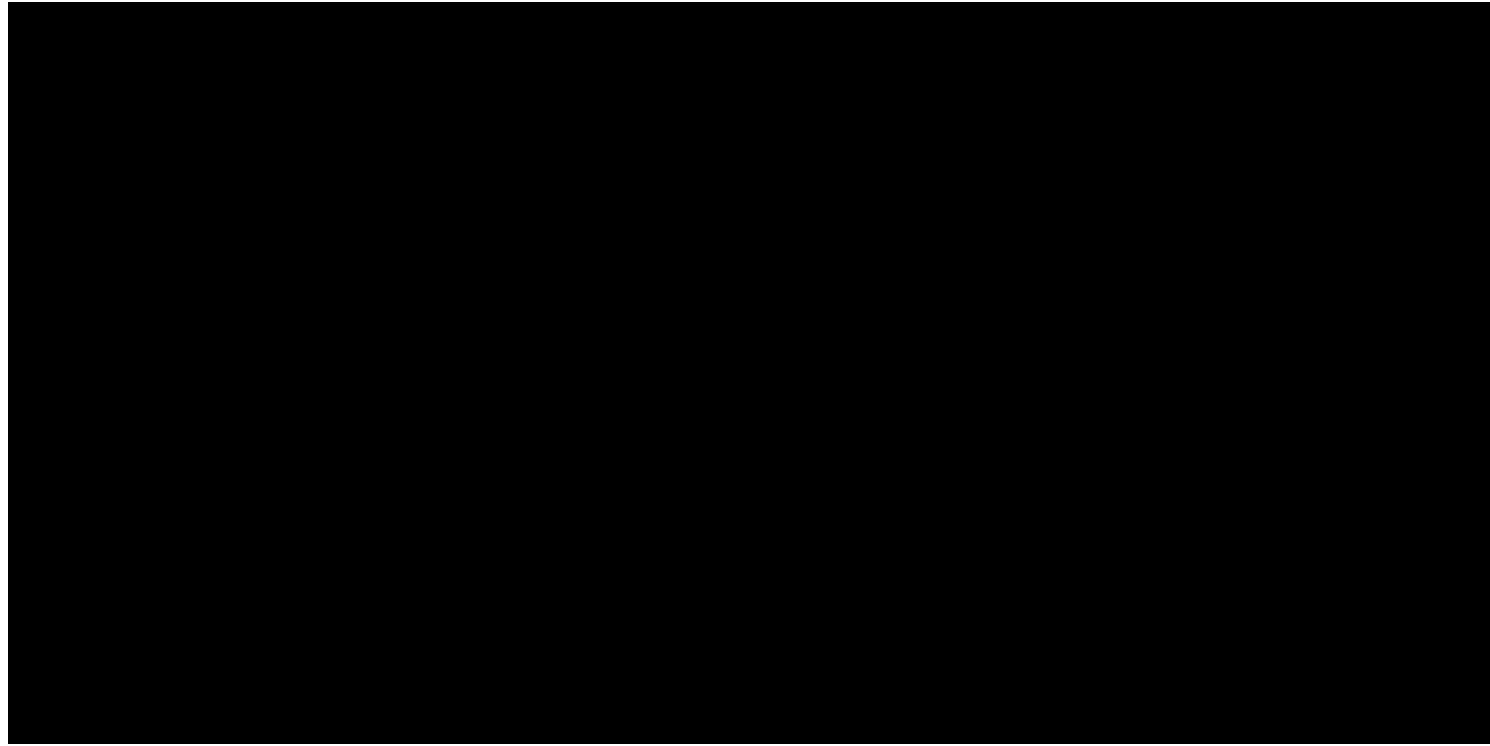
$$\frac{\text{Near Infrared} - \text{Red}}{\text{Near Infrared} + \text{Red}}$$

In your initial research, you discovered that the Near Infrared band was used in both the Agriculture and Color Infrared renderers. The Near Infrared band is vital in identifying and monitoring vegetation. The values in this index are listed on a scale range from -1.0 to 1.0. So, the greater values (green) indicate the presence of rich vegetation in the area.

For more information about the calculation, go to ArcGIS Pro Help: NDVI function.

b Visually survey the results of the Vegetation Index within the study area.

c On the toolbar, click the Swipe tool .



*Step 5c***: Create a vegetation index.*

d In the middle of the map, drag the blue box from one side to the other to compare the green high-value areas of the index with the information in the underlying basemap.

As you previously identified, the green areas in the Vegetation Index appear to correlate to the golf courses and parks.

e On the toolbar, click the Swipe tool again to deactivate it.

To identify the areas of high vegetation in the study area, you will need to create a mask.

- Step 6: Create a vegetation mask

According to a local expert, a vegetation value of 0.45 is considered to be relevant for this area, so you will use that figure when creating a mask. A mask hides certain features in order to allow desired features to stand out. In this case, you will apply a mask to focus specifically on the vegetation areas that could be affected by changes to the water policy.

a Change the renderer back to Natural Color.

Step 6a*: Create a vegetation mask.**

You will use this renderer to allow the masked areas to appear clearly.

- b On the toolbar, click the Mask button  to view the Mask window.

The Vegetation Index is the default choice. The entire visible area of the app will be shown. The initial mask value is 0.5, and you will see an area covered at the top.

To normalize the figure, you will use the study area polygon to focus the area-covered calculation.

- c At the bottom of the Mask window, check the box for Define Areas Of Interest, and then move your pointer on the map near one of the study area corners.

A MapTip appears that says Click To Start Drawing.

- d Click each corner of the study area as closely as possible, double-clicking to finish your drawing.

Note: If you click the edge of the study area polygon, a pop-up will appear, indicating information about the polygon feature layer.

- e In the Mask window, click Apply.

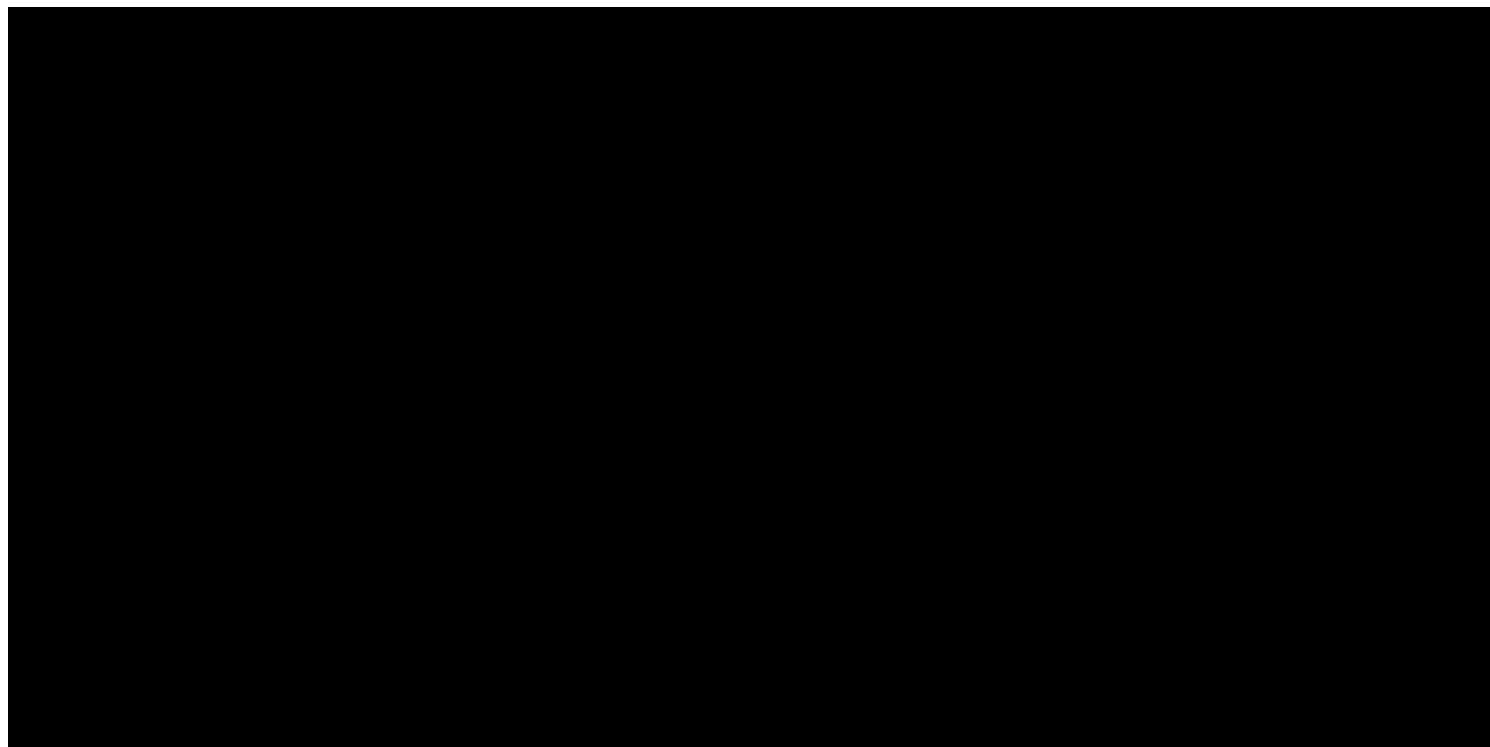


*Step 6e***: Create a vegetation mask.*

The results will then be refined to only appear within the area of interest—in this case, the study area—and the value for area covered will change. If you zoom in to or pan around within the study area, the area covered will update to reflect the amount of vegetation in the current view.

To complete the mask, you will need to adjust the mask value. Currently, it is 0.5, but a local expert has determined that a value of 0.45 is appropriate.

- f Using the Mask slider, adjust the value of the mask to 0.45.



*Step 6f***: Create a vegetation mask.*

Note: Setting the value can be performed by dragging the slider along the axis or clicking the plus (+) or minus (-) buttons for fine-tuning.

- g When adjusting the value, it may take a moment for the features in the map to update.

The mask has been updated and now has a larger area-covered value. The values for the mask cover the vegetation areas in the study area well.

- Step 7: Create a vegetation study area layer

Now you are ready to create a layer that you will use to identify areas that would be most affected by changes to the water policy.

- a At the bottom of the Mask window, click the color wheel down arrow, choose a blue color, and then click Apply, if necessary.

*Step 7a***: Create a vegetation study area layer.*

- b On the toolbar, click the Save Top Layer To ArcGIS Online button 
- c In the Save Result dialog box, for Title, type **NDVI Mask For Water Policy <your initials>**.
You will add your initials to distinguish your layer from others.
- d For Tags, add **ImageryInAction, MOOC**, and then click Submit.
- e If prompted, sign in using your MOOC credentials.
You will now return to your MOOC organization tab and view your saved content.
- f At the top of the web browser, click the Imagery In Action tab to view the MOOC organization home page.

Note: If you closed the organization home page, perform the following steps:

1. Open a new web browser tab, and then go to www.arcgis.com to sign in to ArcGIS Online.
2. Click Sign In and click ArcGIS Login, if necessary, and then type your MOOC username and password and click Sign In.

- g At the top of the Imagery In Action organization home page, click Content.
- h If necessary, under Folders, click the folder that matches your username to see your layer item listed.
- i At the top of the page, click Map to open Map Viewer.
- j In the Layers pane, click Add.
- k In the Add Layer pane, locate the NDVI Mask For Water Policy layer and click Add.

*Step 7k***: Create a vegetation study area layer.*

The mask value is shown as an imagery layer overlaid on the basemap.

You successfully identified some of the areas that have the most vegetation and will most likely be affected by a change to water policy in the area. Using ArcGIS, you accessed dynamic image services, explored different visualizations, and created preliminary analysis products to set up future investigations and analyses.

- l When you are finished, close any open web browser tabs or windows, including the Landsat Explorer app.